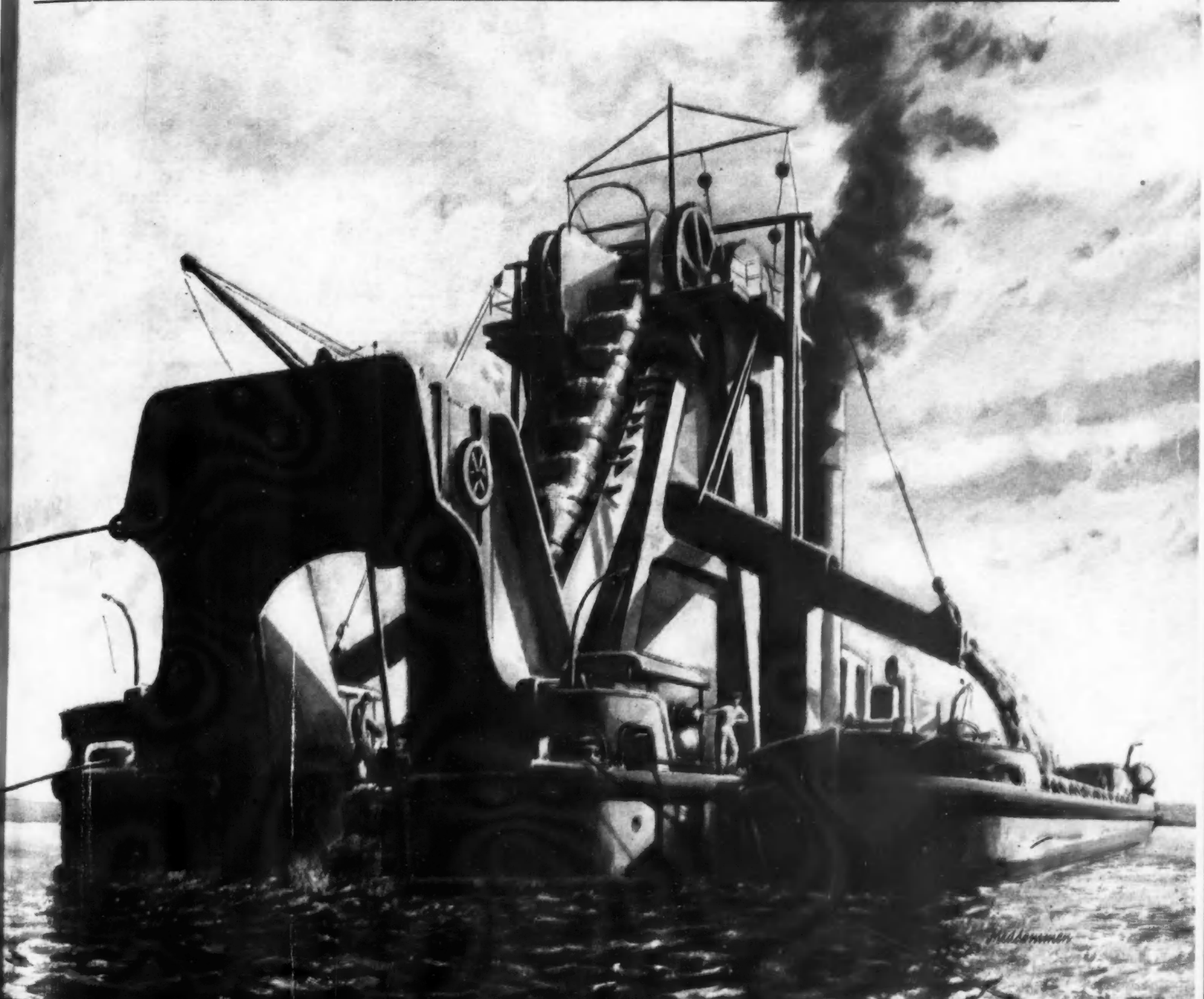
The Dock & Harbour Authority

No. 398. Vol. XXXIV. DECEMBER, 1953 Monthly 2s. 0d.



The Dock & Harbour Authority

An International Journal with a circulation extending to 72 Maritime Countries

No. 398

Vol. XXXIV.

DECEMBER, 1953

Monthly 2s. 0d.

Editorial Comments

The Port of Amsterdam.

The old controversy whether Amsterdam or The Hague is the capital of the Netherlands has again received some prominence during recent weeks. The people of Amsterdam continue to maintain that theirs is the capital city of the country, but Minister Beel, on the other hand, answering a question on the subject, said " Amsterdam is generally considered the capital on account of the swearing-in and investment ceremony of the Sovereign held there, and because its municipality was the greatest and the most populated in the country, both during the days of the Republic of the Netherlands and afterwards. Since the conception ' capital of the country ' lacks essential meaning in Holland, however, there is in my view insufficient ground for determining by law which municipality functions as such."

There is no question, however, that Amsterdam is the chief city of Holland. Originally a small sea-fishing settlement, it has grown into the most important commercial centre in the Netherlands and its port is one of the principal gateways to central Europe with an intricate system of waterways serving a highly industrialised hinterland.

The four chief competitors for the maritime trade in this area are Amsterdam and Rotterdam in the Netherlands and Antwerp and Ghent in Belgium, and the functions of these ports, in addition to serving the needs of their own countries, also include the service of large manufacturing areas of other European nations.

It is clear that these favourable circumstances have contributed largely to the important position that Amsterdam holds at the present time, and that its strategic situation has greatly assisted in the development of the port. This has only been achieved, however, by the exercise of considerable initiative and as a result of much labour on the part of those concerned in promoting its prosperity. Firstly, there was the construction of the North Holland canal to the Helder in order to counteract the adverse effects upon trade caused by the formation of the Pampus sandbank at the entrance to the Y from the Zuider Zee. Secondly, the serious rivalry of Rotterdam, especially with regard to the transit trade, and the inadequacy of the Keulsche Voart which connected the city with the Rhine, led to the construction of the Merwede canal to Gorinchem.

These works, having in the course of time become inadequate, have successively been replaced by new and improved canal communications, both to the sea and to the Rhine, together with such dock installations and other port facilities as became necessary.

In this issue, we are privileged to publish the first instalment of an article, written by Ir. T. J. Risselada, the Chief Engineer of the Port of Amsterdam, in which readers will be able to study the port's development from early times to the present day.

It is a record of continuous enterprise and activity to improve the port and its communications in order to accommodate the increasing size of vessels and to meet all other navigational demands that have been made upon it.

In view of the publicity recently given to the increase in ship sizes and the growing obsolescence of dry dock accommodation in many maritime countries, it is interesting to note the expansion of the shipbuilding and repairing industry in Amsterdam and the steps that are being taken to provide large graving and floating docks.

The rehabilitation of the port following its destruction by the Germans, has involved an impressive programme of repair works and new development. The progressive outlook of the management regarding the " human factor " is also worthy of note. Many welfare measures have been introduced, including a decasualisation scheme for dock workers and a dockers' training school. This policy has resulted in greater efficiency in cargo handling with a corresponding increase in productivity.

Coastal Flooding.

After the flooding which occurred on 1st February, 1953, causing much havoc along the coasts of Great Britain and Holland, the United Kingdom Government appointed a Departmental Committee on Coastal Flooding under the chairmanship of Viscount Waverley (Chairman of the Port of London Authority). The terms of reference included the examination of the causes, and the possibilities of a recurrence of floods in Great Britain; the consideration of margins of safety for sea defences, and of systems of warning to lessen risks to life and property; the review of the lessons to be learned from the disaster, and the administrative and financial responsibilities of the various bodies concerned in providing and maintaining sea defences and replacing them in the event of damage.

The Departmental Committee has already issued an interim report and has effected some co-ordination of tidal predictions and warnings under a new system. It also has made some progress in its deliberations on other matters. Meanwhile, the London County Council, who are responsible for flood prevention in the County of London, has received from its Rivers and Drainage Committee a report upon a Statement of Evidence, which it proposes the L.C.C. should place before the Departmental Committee.

This report contains *inter alia* a number of specific proposals that affect the County of London, some of which it is suggested should be investigated by a Joint Flood Prevention Committee. For example, prescribing the standard flood prevention levels for both banks of the whole of the tidal Thames, the probability of a recurrence of high tides due to storm surges in the North Sea, and the effect of subsidence of South-East England.

The creation of a Joint Flood Prevention Authority for the whole tidal Thames is a progressive proposal provided its executive powers are sufficiently adequate. There may, however, be some danger of overlapping, if this Joint Authority, responsible only for the tidal portion of the Thames, were given the task of investigating the matters mentioned in the preceding paragraph with their concomitant scientific data and problems.

In our view a better scheme would be that suggested in these columns last February, i.e. that all research work should be carried out by one Department for the benefit of all the various bodies responsible for coast defence and flood prevention around the coasts of Great Britain. This Department should also be responsible for the correlation of all coast defence schemes.

The most controversial proposal which the L.C.C. Committee suggests should be investigated by the proposed Joint Authority is " the construction of breakwaters across the estuary (Thames) westward of the Isle of Grain with an opening over the navigation channel to provide the necessary facilities for shipping." This recommendation—assuming a barrage or dam is envisaged—recalls the project which was considered in 1904 and again in 1935 when the Thames Barrage Association suggested the building of a River Thames barrage at Woolwich.

A public enquiry regarding this proposal was planned in 1939, but never held owing to the unsettled international situation. At that time objection was raised by the Port of London Authority on the grounds that a barrage with a system of locks in the main

Editorial Comments—continued

channel—even supposing the locks to be capable of coping with the incoming and outgoing shipping—must entail delay and inevitably cause congestion and confusion by reason of the vast number of vessels involved.

Opposition to the scheme was also expressed by the London County Council and other public bodies, whose services and interests would have been vitally affected. Presumably the Rivers and Drainage Committee of the L.C.C. have now been able, by further investigation and research, to satisfy themselves that the drainage and sewage disposal difficulties with which they were then mainly concerned can be successfully resolved.

It has also been proposed by the L.C.C. Committee that the possibility of providing artificial overspill areas both down and upstream of London might be investigated in order to minimise the effects of abnormally high tides.

As we have suggested in previous issues, the physical effects upon the River Thames of the two above-mentioned projects could well be investigated by the Port of London Authority's tidal model of the River Thames.

It is not yet known whether the report of the Rivers and Drainage Committee will be adopted by the London County Council. While London is most vitally affected, the question of coast defence and flood prevention concerns the coastline of the country as a whole, and the Departmental Committee set up by the Government has a unique opportunity of removing many existing anomalies, such as overlapping and conflicting interests, and of placing this important matter upon a sound and permanent basis.

Ouwerkerk Gap Closed.

Although the next few weeks, with the storms to be expected at this time of the year, will remain a period of anxious watchfulness, the successful sinking of the fourth caisson on November 6th last in what remained of the great Ouwerkerk dyke gap marked the end of the first stage of rehabilitation. As far as present indications go, the great struggle against the waters of the North Sea, let in by the disaster of last February, has been won.

To appreciate the extent of the relief felt by the people of Holland, it is necessary to bear three things in mind: that a previous attempt, in August, to close the gap by means of a circular dyke had failed because the eastern jetty, meant to support one of the two caissons then to be used, had given way; that the new operation which then became necessary has been a constant fight against time, in view of approaching autumn and winter conditions; and that, up to the last minute, no one could be certain that the sinking of the last caisson would be achieved successfully.

During the week preceding the final operation, three British-built caissons were sunk in their appointed places. On the night of the final closing of the gap, Queen Juliana watched the scene from aboard a small ship, and when the fourth caisson had been successfully sunk in the glare of three huge electric light standards and two powerful searchlights, Her Majesty broadcast her congratulations to the nation.

The engineers responsible for the restoration work at Ouwerkerk have announced that some weeks will have to pass before the work of pumping the polder dry can begin. This is because it would be useless to begin pumping until the recently closed gap has been made completely water-tight.

The four caissons which were sunk in order to close the wide breach have stopped the constant in-and-out flow of enormous quantities of water; but there are innumerable minor points of leakage where they join. Even the smallest leak is important because there is always the danger that it may gradually grow larger unless it can be stopped altogether. This work is now being pushed forward with all possible speed and energy.

The Docks of London.

Delivering his presidential address to the Institution of Civil Engineers, early last month, Mr. W. P. Shepherd-Barron, until recently the Chief Engineer of the Port of London Authority, took as his subject the Docks of London. The salient features of his remarks will be found on a following page.

Mr. Shepherd-Barron's views concerning the present day cost of port works compared with the cost of ship construction and the value of the cargoes they carry, can, of course, only be regarded as of broad application. One important point is that port works in general must be built on a relatively long term policy, and cannot be scrapped and rebuilt on a twenty or a twenty-five years' plan like a ship.

It is sometimes not fully appreciated to what extent large ships are responsible for the increase in the cost of building and maintaining the ports that accommodate them. This may be partly recovered by increased ship dues, etc., but it is doubtful in some cases whether the national interest is best served by building ships of continually increasing dimensions. Some measures of compromise and collaboration between shipowners and port authorities now seems to be essential.

Indeed as Mr. Shepherd-Barron points out, although the increase in ship sizes have brought about larger docks and deeper approaches thereto, many existing port works and particularly the depth of their channels, have of late imposed some modification or limitation upon ship dimensions.

Drydock Facilities on the Clyde.

At a recent meeting of the Clyde Navigation Trust, it was decided to give full support to the representations being made to the Admiralty for the construction of a large graving dock in the Greenock area. The meeting agreed that such a dock was the Government's responsibility, the building of which would be in the national interest.

Consideration has been given in the past to the relative merits of a large dock at Greenock and a smaller one (between 800-ft. and 900-ft. long, 95-ft. broad and 25-t. deep) at Glasgow. It has now been agreed that the plan for a dock at Glasgow should be abandoned and that every effort should be made to construct a dock at Greenock 1,200-ft. in length, not less than 120-ft. wide and having a depth on the sill of at least 40-ft.

Discussions on the subject of the proposed graving dock on the Clyde for Admiralty and other requirements started in December 1945, were re-opened in March 1946, and again last January.

During the summer, several copies of a plan for the establishment of the dock at Greenock were forwarded to the Admiralty by the Greenock Harbour Trust. This plan made it clear that if the Admiralty gave its approval and were willing to finance the work, Greenock would have the world's largest dry dock capable of accommodating the biggest ships yet built, or likely to be built for many years to come.

It was suggested that the graving dock should be built on the site of the present East India and Victoria harbours over an area of 25 acres, and that the present channel should be widened and deepened to provide an approach about 1,000-ft. wide and 40-ft. deep at low water. This would improve the existing channel by eliminating a rather sharp bend opposite Custom-house Quay. The cost of the plan is estimated to be between £3,000,000 and £3,500,000.

The fact that the Clyde Navigation Trust has now agreed to support the Greenock Harbour Trust on the scheme, lends much greater weight to the pressure being brought to bear on the Government to finance the cost of the work, which would provide increased employment in the area.

Convention of Bombay Dock Workers.

At a convention held recently, the Bombay Dockworkers' Union decided to increase the scope of its activities. It was agreed that the union should start educational classes in English, Urdu and Marathi and publish a fortnightly Urdu magazine in addition to its two other publications in Marathi and English.

In his report to the Convention, the General Secretary of the union, criticised the Indian Government for its failure to convene a meeting of the Dock Workers' Advisory Committee (constituted in 1951), and recommended that a new body be charged with the administration of the Bombay Dock Workers (Regulation of Employment) Scheme, 1951. In two unanimously-adopted resolutions, the Convention called upon the Government to include certain specified categories of workers in the Bombay Dock Workers' Decasualization Scheme and directed the General Secretary to seek affiliation with the International Transport Workers' Federation.

The Port of Amsterdam

Post-War Development of an Historic Port

By Ir. T. J. RISSELADA, Chief Engineer, Public Works Department,
Chief of the Harbour Works Division.

I. Outline of the Historical Development until the Second World War.

DURING the early history of the Netherlands her western part was a more or less shallow sheet of water, shut off from the North Sea by a ridge of dunes. Sand and clay being carried and deposited by two large rivers—the Rhine and the Meuse—and by the sea, that sheet of water gradually became shallower, so that eventually vast marshes came into being, traversed by all kinds of rivers and creeks, and extensively covered with woods. Through a few gaps in the ridge of dunes, however, the sea could invade the country at high tides and flood it. That also happened when the rivers rose to high levels; so the low-lying land was flooded fairly regularly. After each inundation a thin layer of clay or sand remained, and the decaying vegetable matter in the marshes produced peat-bogs. From the great thickness of some of these layers of peat, and from their presence at great depths below the present level of the sea, it may be inferred that, in the course of time, the land must have subsided considerably with respect to the level of the sea. In this way more or less soft strata of clay, peat or sand came into being on the deposits carried by the rivers, the sea or the glaciers during the diluvial periods, which strata—dependent on various circumstances—became more or less thick. A few centuries after the beginning of our era an increasing rise of the level of the sea began to erode the low-lying soil. Great portions of the peat-bogs were swept away by high storm-floods. Thus gradually the Zuyderzee and the Y originated. By building dikes the destructiveness of the sea was set within bounds, and the areas enclosed by the dikes were made and kept habitable by controlling the levels of the water in those areas.

In these low countries, where the River Amstel debouches into the Y, Amsterdam came into being some seven hundred years ago. At first no more than a small fishing-village, it soon developed into an important centre of commerce and navigation which contested the trade and shipping to the countries along the Baltic with the Hanseatic towns, and finally surpassed them. In the 16th and 17th centuries the Amsterdam fleets breasted the waves of the seven seas and, owing to her staple-market of corn and Indian produce, the town developed into one of the greatest emporiums of Western Europe. Up to the end of the 18th century Amsterdam managed, more or less, to maintain that important position, but during the wars with Napoleon commerce and navigation were practically closed down, so that in the early part of the last century the citizens of Amsterdam had to revive commerce and navigation.

That task was the more strenuous because, in consequence of ships getting bigger, the ship-canals connecting the port to the North Sea and the hinterland could only be navigated with very great difficulty or not at all. After having succeeded in improving those junction-canals during the latter part of the 19th century, Amsterdam once more became one of the principal ports of Western Europe. For that purpose it was necessary not only to improve the entrances to the harbour, but also to make the harbour itself fit for handling the much larger vessels that now arrived at Amsterdam. For sundry reasons the older docks no longer satisfied even moderate demands of shipping. Hence the quays alongside which sea-going ships are now berthing have all been constructed since the opening of the North Sea Canal, which took place in 1876.

The construction of this canal meant a very significant improvement for the port, not only because the connection with the North

Fig. 1. Connections of Amsterdam with the North Sea. Ancient sailing route via the Zuyderzee.

Sea was greatly improved, but also because, as a result of the enclosing dike across the Y at Schellingwoude, whose construction formed part of the works for the North Sea Canal, the silting up of the Y was eliminated. In the 19th century particularly silting up had caused serious difficulties in the maintenance of the necessary depth of the fairway in the harbour, and eventually very seriously menaced the survival of Amsterdam as a port. The North Sea Canal, about 15 miles (24 kilometres) long, superseded the North Holland Canal about 50 miles (80 kilometres) long, which had been built in 1819-1824, after it had become evident that the old route via the Zuyderzee (Fig. 1) was quite inadequate for navigation purposes in consequence of the continually increasing sizes of ships. The North Sea Canal has been kept adapted to the requirements of navigation by successively building larger locks at the entrance (Fig. 2) and by widening and deepening the canal itself. At present ships can reach the harbour of Amsterdam from the North Sea even under adverse conditions in about two hours, thanks to the harbour radar installation at the entrance.

For help in compiling this article I am specially indebted to Mr. Hagtingius whose assistance in collecting the data and the photographs as well as in supervising the drawings, etc., has been of great value.
T.J.R.

The Port of Amsterdam—continued

Fig. 2. The entrance locks to the North Sea Canal at IJmuiden. On the right, the locks built during the construction of the canal, 390 by 59-ft. (119 by 18 m.); depth of threshold 25-ft. (7.50 m.) below level of canal. Centre: the lock completed in 1896: 738 by 82-ft. (225 by 25 m.); depth of threshold 32-ft. (9.65 m.) below level of canal. On the left, the lock put to use in 1930: 1,312 by 164-ft. (400 by 50 m.); depth of threshold 48-ft. (14.50 m.) below level of canal.

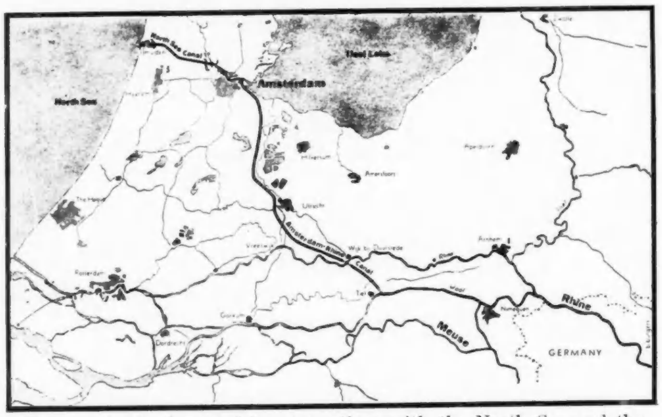


Fig. 3. Amsterdam and its connections with the North Sea and the Rivers Rhine and Meuse.

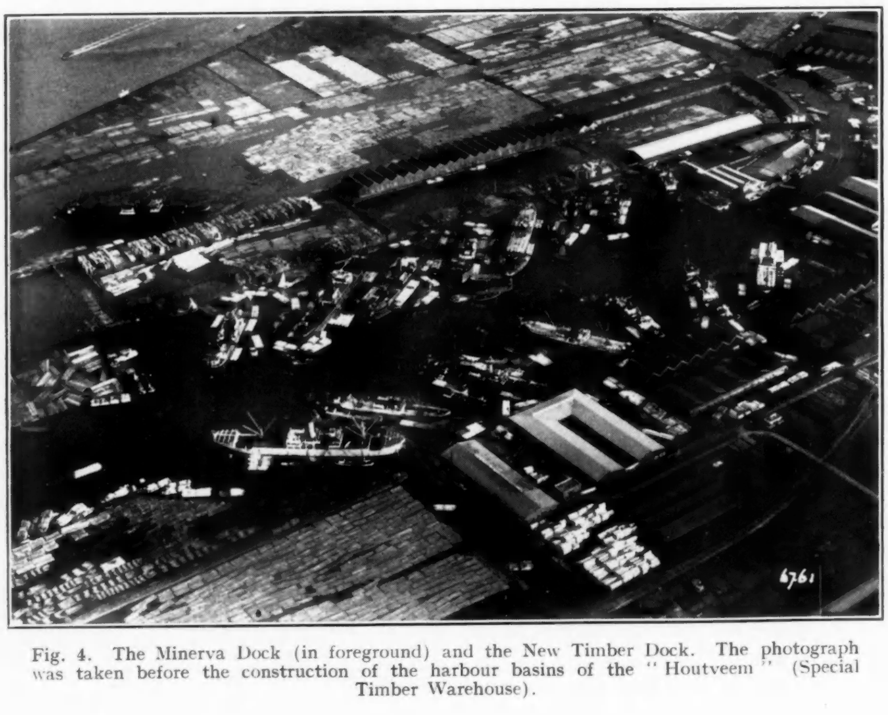


Fig. 4. The Minerva Dock (in foreground) and the New Timber Dock. The photograph was taken before the construction of the harbour basins of the "Houtveem" (Special Timber Warehouse).

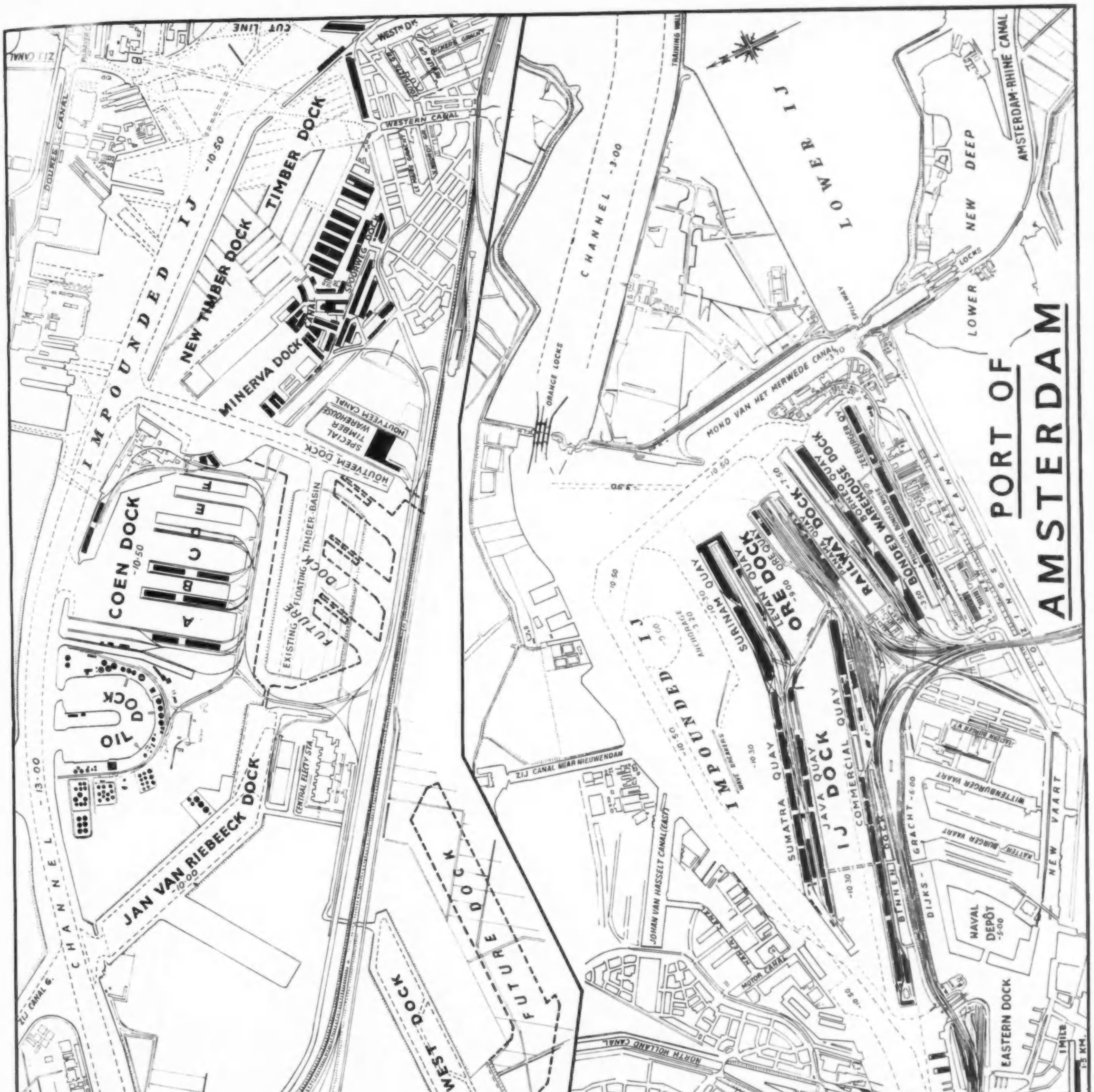
Safe navigation, secure under all circumstances in this straight canal, which is lighted by sodium lamps during the hours of darkness and where there are no currents, will take still less time in the near future when the two railway bridges across the canal have been replaced by tunnels, Building the first tunnel has already progressed considerably, and when this has been finished, the construction of the second tunnel is hoped to be well under way.

The connection of the port with its hinterland was greatly improved in 1825 and 1892. The sizes and numbers of ships, however, kept on increasing, so once more the connection of the port of Amsterdam with the Rhine had to be improved. This happened when the Amsterdam-Rhine Canal was opened in 1952. By shortening the waterway from Amsterdam to the Waal—the south branch of the Rhine, forming the best connection—by about 25 miles (40 kilometres) and by taking several measures to prevent undue delay for navigation, the time for sailing from Amsterdam to the Rhine was reduced by about 50 per cent. All bridges were built high above the canal and under normal circumstances the number of times that locking through has to take place, has been reduced to two. On a few days only per year—dependent on the levels of the rivers—will it be necessary to lock through three times.

Since the North Sea Canal, the Amsterdam-Rhine Canal and the area of the port of Amsterdam have the same water level they form one single dock (Fig. 3) without currents or variations of water level stretching from the sea-locks at IJmuiden—which are the biggest in the world (1,312 x 164-ft. = 400 x 50 m.; depth of the threshold 48-ft. = 14.50 m. below level of canal)—to the locks at Wijk bij Duurstede, which are among the biggest locks for inland navigation in the world (1,180 x 59-ft. = 360 x 18 m.; depth of the threshold 13-ft. = 4 m. below level of canal).

The harbour of Amsterdam as it is at present was laid out in the years after the opening of the North Sea Canal. It has several basins in which ships are loaded and unloaded alongside the quays, not subjected to the disadvantages of varying levels. The Railway Dock, completed in 1877 was the first to be constructed for larger ships. The north quay along this dock, the Panama-Quay, has been occupied by sheds run by the railway company, while along the south quay there are big storage-places for coal and ores. In 1880 the "Handelskade" (Commercial Quay) was finished. The west part of this quay is taken up by goods-sheds of the regular services to the principal British ports, the Faroe-islands and Iceland. Ships which maintain regular cargo- and passenger-services to the principal ports of the west coast of Africa are also handled in this part of the quay. In the central part there are large warehouses and refrigerating stores, whilst the goods-sheds for the regular cargo services to the east coast of South America are situated at the eastern end.

At the west side of the town in the years 1876-1880 the "Houthaven," the "Nieuwe Houthaven" and the "Minervahaven" (the Timber-Dock, the New Timber-Dock and the Minerva-Dock) were built (Fig. 4), which, together with the "Vlothavens" (Raft Basins) built in 1931, are—after London—the most extensive range of timber-docks in Western Europe. In these docks, as contrasted with the other docks of the harbours, ships are unloaded while being moored to buoys. In 1889 the "Petroleumhaven" (Oil Dock) was completed. The storage capacity of that dock was increased when required, so that in 1939 6,540,000


PORT OF AMSTERDAM
IMPOUNDED IJ
TIMBER DOCK
NEW TIMBER DOCK
MINERVA DOCK
SPECIAL TIMBER WAREHOUSE
HOUTVEEM CANAL
HOUTVEEM DOCK
COEN DOCK
-10.50
A
B
C
D
E
F
EXISTING FLOATING TIMBER-BASIN
FUTURE DOCK
OIL DOCK
JAN VAN RIEBEECK DOCK
-10.00
CENTRAL ELECTY STA.
CHANNEL -13.00
ZIJ CANAL G.
NORTH SEA CANAL
NEW DOCK
WEST DOCK
FUTURE DOCK
WESTERN CANAL
CUT LINE
ZIJ CANAL
CHANNEL -3.00
ORANGE LOCKS
LOWER IJ
NEW DEEP
AMSTERDAM-RHINE CANAL
LOWER
LOCKS
MOND VAN HET MERWEDE CANAL
BONDED WAREHOUSE DOCK
RAILWAY DOCK
ORE DOCK
LEVANT QUAY
SURINAM QUAY
IJ DOCK
JAVA QUAY
SUMATRA QUAY
COMMERCIAL QUAY
ZIJ CANAL NEAR NIEUWENDAM
JOHAN VAN HASSELT CANAL (EAST)
JOHAN V. HASSELT CANAL (WEST)
PAPAVER CANAL
MOTOR CANAL
NORTH HOLLAND CANAL
WITTENBURGER VAART
KATTENBURGER VAART
NEW VAART
NAVAL DEPÔT -5.00
EASTERN DOCK
BINNEN
DIJKS
GRACHT -6.00
OPEN HARBOUR FRONT
CHANNEL -10.5
WESTERN DOCK
SCALES
MILES
0
1/2
1 MILE
KM.

The Port of Amsterdam—continued

cu. ft. (185,000 cubic metres) of oil could be stored in the tanks. In 1896 the building of quay-walls along the Y-island was started. That island, like the "Handelskade," has been built up by dumping and discharging sand into the sheet of water of the enclosed Y. Whenever required, parts of the south or north sides of the island were provided with quay-walls and sheds were built along the quays. Thus, during a period of about twenty-five years the Java-, the Levant-, the Sumatra- and the Surinam-Quays came into being. At the west end along both the Java- and the Sumatra-Quays are the sheds and warehouses of the shipping company that maintains line services to Indonesia with its fleet of cargo- and passenger-ships. The east part along both the Levant- and the Surinam-Quays is taken up my sheds for the cargo-services to the ports of the Mediterranean, the Black Sea, the Baltic, Spain, Portugal, the west coast of South America, and the West Indies. The cargo-ships plying between Amsterdam and the ports along the Rhine as far as Basle are also berthed here. At the central part of the Java-Quay are the sheds for the cargo-services to the ports in South and East Africa and the Persian Gulf. As an extension of the "Handelskade" in 1898 the "Ertskade" (Ore-Quay) was built. In the south-east part of the area of the harbour in the years 1898-1900 the basin was dug and the warehouses were built for a new Municipal Bonded Warehouse. To the east of the bonded warehouse the "Zeeburger" Quay was completed in 1913. In 1915 the Bonded-Warehouse-Dock (Fig. 5) was extended to the north and the erection of the Borneo-Quay was started. At the east part of this quay are the warehouses of the regular cargo-services to Indonesia and New-Guinea. With the completion of the Borneo-Quay, the possibilities of extending the harbour at the east side of the town were exhausted.

So all the extensions that have been accomplished since are situated in the west part of the harbour where the "Coen" Dock was completed in 1933. Along the north-west and north quays of this dock are coal- and ore-stores, while the dock offers berths to the cargo-ships plying between Amsterdam and Norway and Finland.

In order to provide for the need of industrial sites that are not only situated along deep fairways, but have the disposal of good roads and railways as well, the construction of the "Westhaven" (West-Dock) was started in 1930. The first part of this dock was completed in 1931.

Besides the afore-mentioned ranges of docks, laid out to the east and to the west of the town before the Second World War, there are the basins more especially intended for inland craft, spread out over the entire area of the harbour. It is especially from the surroundings of the "Openhavenfront" (Open-Harbour-Front) (Fig. 6), since olden times the centre of navigation across the Zuyderzee, that inland navigation maintains connections with nearly all important home places and with the principal places in the adjacent territories abroad via the very extensive network of waterways that traverses the Netherlands in all directions.

II. Destruction to the Port and Port Installations During the Second World War

The violence of the Second World War inflicted heavy blows upon the port of Amsterdam. The North Sea Canal was made unnavigable by obstructions consisting of sunken ships at Ymuiden and the Oil-Dock. Besides, the largest entrance lock was damaged, and all machinery for moving gates, etc., was carried away. Nearly all port cranes, conveyors, corn elevators and floating cranes were destroyed and considerable portions of the wharves were rendered unfit for use. In the Oil-Dock only one small tank of 7,000 cu. ft. (200 cubic metres) remained intact. A great number of vessels were sunk at different places in the harbour to obstruct the fairway. The largest floating dock—a 25,000-ton one—with an Italian steamer in it, was completely wrecked. Slipways were demolished, practically all the cranes and several valuable plants being destroyed in the process. Great damage was inflicted to sheds and warehouses. By exploding mines at distances of 98-ft. (30 m.) behind almost all the quay-walls of the Coen-Dock, nearly the entire length of quays for sea-going ships or barges was destroyed. It is difficult to estimate the total damage to the harbour of Amsterdam, but a very rough estimate assesses it at ten million pounds sterling at the standard of prices in 1945.

III. Outline of Development after the Second World War

Plans for the reconstruction of the port were already prepared during the occupation. By doing so it was possible—with the aid of units of the Allied forces—to start making the entrances to the port free immediately after the liberation, so that after a lapse of only two months, the larger ships were able to reach the various docks, and after rather more than a year, unlimited passage through the North Sea was again feasible.

By that time a considerable part of the equipment of the port had also been repaired. In consequence of the construction of the entrance-canal to the "Houtveem" (special timber warehouse) the existing connections by road and railway to the Coen-Dock had to be severed. In order to adapt the lengths of the piers to the modern demands of navigation, the new connections as well as the new railway marshalling yard that had become necessary were moved southward of the old ones. By doing so it became possible to make the two west basins of the Coen-Dock about 328-ft. (100 m.) longer, so that now two up-to-date cargo-ships one behind the other can be berthed alongside the piers.

The first extension of the harbour completed after the liberation was the considerable enlargement of the "Westhaven" (West-Dock), into which water was admitted in 1948. After that the construction was commenced of the Jan van Riebeeck-Dock, which was completed recently. Close to that dock a new power-station is being built, which will provide for the greatly increased demand for electrical energy. Plant for supplying half the ultimate power of 400 mw. is almost ready. The great quantities of cooling water for that power-station are pumped out of the West-Dock via a canal and released into the Jan van Riebeeck-Dock, which is expected to be kept permanently free from ice in that way. In order to provide for favourably situated industrial sites, extensive areas along the two docks have been raised with sand obtained from the docks

Fig. 5. Eastern Harbour area. In the foreground the Bonded Warehouse Dock with the Borneo Quay on right, and the Municipal Bonded Warehouse on left.

The Port of Amsterdam—continued

Fig. 6. Surroundings of the Open Harbour Front.

by suction dredgers. This sand was also used for raising building sites at the west side of the town. Further extension of the West-Dock provides potentialities to create extensive, well situated industrial sites.

The erection of the " Houtveem " (special timber warehouse), the most recent extension of the Timber-Dock, was completed in 1950. Those premises have been equipped with facilities for the storage and transfer of hard and soft woods on behalf of third parties. In the large shed of 161,560 sq. ft. (15,000 sq. m.), about 1,766,000 cu. ft. (50,000 cu. m.) of timber can be stored.

In order to satisfy the demands made on wharves for the rapid handling of commodities with the aid of up-to-date appliances, a considerable part of the wharves for sea-going ships was modernised.

So far the need for fresh sites for wharves, greatly augmented by the increasing shipping of Amsterdam, could be provided for by taking more and more lengths of quays in the repaired Coen-Dock into use and by building new sheds. However, there the available length of quays is limited, so that new possibilities have to be sought. Consequently the plan arose to reconstruct the Raft-Basins south of the Coen-Dock into a dock for general and bulk goods, accommodation and equipment of which will satisfy the most exacting present-day requirements.

IV. Equipment, Management, etc.

The equipment of the Amsterdam harbour (Fig. 7) satisfies the highest requirements for handling bulk goods and consequently is able to meet all demands made upon it. However, in consequence of her historical development, Amsterdam is first of all a port for dealing with general cargo. The equipment of the harbour for this purpose is up-to-date and nearly all wharves have sheds or warehouses for storage purposes. To enable the cargo to be handled as rapidly and as simply as possible, practically all these buildings are provided with customs facilities, enabling the commodities stored in them to be exported in bond. They are owned by the Municipality or by private firms. If desired, the latter may hire sites, provided with road and railway-connections, from the Municipality, and then erect cranes, sheds, etc., there. If desired, the Municipality also provides the necessary sheds and facilities for hire.

The unloading and loading of ships can always proceed rapidly and uninterruptedly, the water in the harbour being quiet and remaining at the same level in all harbour-basins and practically throughout the entire town. This favourable circumstance enables goods to be carried from one ship to another or from ship to warehouse in other parts of the harbour or in town by means of so-called "dekschuiten" (flat-topped barges) (Fig. 8), which can be operated by one man and are a very cheap means of conveyance. They carry some 20 or 30 times as much as a truck though requiring no more than approximately the same power; there is less risk of the cargo being damaged, and if necessary, they act as cheap temporary stores, which can easily be moved. That transport by these barges has become so characteristic and popular for the port of Amsterdam can be explained by the canals intersecting the town and by the fact that the handling of goods is effected quickly and simply owing to the slight difference between the heights of the quays and of the deck.

Owing to its favourable means of communication industry gravitates naturally to the port. Hence it has become one of the most important industrial centres of the Netherlands, particularly in the last few decades. By the recent establishment of important industries along the lateral basin of the West Dock, and the west side of the entrance of the Jan van Riebeeck Dock, a further expansion of industrial activity in the harbour area has been effected. The shipbuilding and ship repairing industry is also expanding. By the construction of a graving dock, with a length of 800-ft. (245 m.), an entrance width of 110-ft. (33.5 m.), and a capacity of approximately 45,000 tons, and by enlarging one of the floating docks, increasing its lifting capacity from about 7,500 tons to 9,000 tons, the dock capacity of the harbour will shortly be considerably enlarged.

From the above it will be seen that the port has been adapted to the highest requirements of shipping. However, for rapid and competent handling of goods a satisfactory technical equipment of

Fig. 7. Details of Equipment of the Port.

Length quays for sea-going vessels	15 km (9 miles)
Length quays for inland craft in	
the port area	12 km. (7.5 miles)
In the town	5 km. (3 miles)
Number of berths for sea-going vessels on buoys and mooring posts	95
Total length of these berths ...	11.8 km. (7 miles)
Total space of sheds in the port district	2,251,828.8 sq. ft. (209,200 m2)
Total space of warehouses in the port district	2,557,526.4 sq. ft.* (237,600 m2)
Timber sheds	1,122,685.2 sq. ft. (104,300 m2)
Special timber warehouses ...	161,460 sq. ft. (15,000 m2)
*Including 183,000 sq. ft. refrigerating stores.	
Port cranes and loading bridges	170 (from 1-10 tons)
Floating cranes	38 (from 2½-150 tons)
Storage capacity granary ...	28,000 tons
(provided with pneumatic equipment for discharging)	
Floating grain elevators ...	6
Storage capacity of tanks for mineral oils	71,689,244 cub. ft. = 203,000 m3
Storage capacity of tanks for edible oils	1,004,131 cub. ft. = 29,000 m3
Dry docks:	
Floating docks	6 (300-25,000 tons)
Graving docks	3 (12,000-30,000 tons)

Bunkering stations for oil and coal available.
All quays are provided with railway connections.
The lifting capacity of the biggest modern port cranes for general merchandise is 2½-5 tons at a radius of 39-19.5 yards.
Lifting capacity of floating cranes for general merchandise 2½ tons; floating derricks up to 150 tons

The Port of Amsterdam—continued

Fig. 8. Unloading goods out of a cargo ship on to a "dekschuit" (flat-topped barge) with the aid of a port crane.

the harbour is not enough. If attention is not also given to the "human factor" however perfect the other facilities may be, the desired results will not be achieved. Great attention has therefore been paid to this factor, particularly after the Second World War. At present 64 concerns are co-operating in order to establish together with the dockers' unions the best possible labour conditions for the dock workers. They have succeeded in giving permanent work to large numbers of dockers, many of whom have been incorporated in shifts which are employed as far as possible by the same concerns, the purpose being to raise productivity. In addition, training is given to the men, as a result of which productivity is improved, and the goods are handled more competently. By advanced social measures, such as pension schemes, the security of the dockers has been considerably improved. A decasualisation scheme that guaranteed a payment of 70 per cent. of their standard wages in the event of no work being available has also been introduced.

The Amsterdam harbour is managed by the Municipality, which has delegated its executive task to three municipal services. The "Havendienst" (Harbour-master's office) deals with nautical matters. Commercial affairs, such as letting wharves and industrial sites, sheds, etc. running the Municipal Bonded Warehouse and the Municipal Oil Bonded Storage, are dealt with by the "Dienst der Havens en Handelsinrichtingen" (Port Management). This service also attends to the purchase, hiring out and maintenance of all dock-side cranes and floating cranes owned by the Municipality. The lay-out of harbours, quays, industrial sites, the building of sheds, etc., and the upkeep of practically all municipal property in the harbour come under the control of the "Dienst der Publieke Werken" (Public Works Department), which has a special sub-department for those duties.

The exclusive right of piloting sea vessels navigating the North Sea Canal belongs to the State. Pilotage is compulsory, the central authority for the stations of Amsterdam and IJmuiden being a Director of Pilotage. Under his management are also the beacons, lightships, lights, etc. The pilotage-service is performed by pilots duly examined and sworn and provided with a commission to that effect. A steamer with pilots cruises off IJmuiden. All pilots at the stations of Amsterdam and IJmuiden are qualified for piloting vessels from the North Sea through the North Sea Canal to and from Amsterdam. The amount of pilotage-dues is calculated according to the vessel's draught of water in decimeters and according to the season (winter or summer) in which the voyage commences.

(to be continued)

Salvage at the Port of Liverpool

Anomaly of Expenses Incurred

In his annual statement to the Mersey Docks and Harbour Board on 26th November last, the Chairman, Col. J. G. B. Beasley, M.C., T.D., D.L., referred to the 100-years-old Act that makes the Port of Liverpool financially responsible for the salvage and removal of wrecks within the port area. Under the present statutes, if a ship is wrecked in the port, the Board must pay the expenses of salvaging her. If the recovered value is more than the cost of the work, the Board have to return the balance to the owner. If there is a loss, however, the Board must stand it.

An outstanding example of this anomaly is provided by the "Empress of Canada" which was destroyed by fire last January. In this instance, it is expected that the total salvage costs will amount to £250,000 but that the scrap value of the vessel will be only about £50,000.

Col. Beazley recalled that in his statement last year he indicated that the opening months of the financial year now under review were showing a deterioration of trade. That deterioration, in both the inward and the outward foreign traffic of the port, continued until the spring of this year, when a marked improvement in inward traffic set in. For the second year in succession the tonnage of vessels entering the Mersey had been a record, and the quay congestion which became somewhat apparent in the early part of 1952 had not displayed itself during the year under review.

Improvement Works.

Considerable progress has been made during the year on the great programme of reconstruction, the largest item being the Langton-Canada scheme, and work here had been speeded-up and was proceeding satisfactorily. Shed reconstruction had been completed at the North-West Langton Branch Dock, South-West Brocklebank Branch and South-West Trafalgar. Further reconstruction was in progress at North Victoria and South Kings No. 1. In addition, considerable repair work had been carried out all over the estate and in the warehouses and this was being facilitated by the easing in the supply position of materials, principally steel and timber.

The iron ore berth at the north side of Bidston Dock was completed and about to commence operation — a new development greatly in the interests of the port.

Following long negotiations, work had commenced on the modernisation of the Langton and Birkenhead graving docks, the first phase of a general modernisation scheme for all their graving docks.

The conservancy position had not been without some anxiety for them owing to the somewhat abnormal siltation which had been experienced in the last year or two. This was under careful observation and the regime of the river and estuary, so vital to the port, was being strictly preserved.

Problem of Salvage Costs.

Referring to the port's peculiar position regarding ship salvage, Col. Beazley said: "In January the port met with a disaster due to the fire on the "Empress of Canada" in Gladstone Dock and the subsequent capsizing of that vessel. The work in connection with the lifting operations is well in progress and it is hoped that the vessel will be uprighted and subsequently removed early next year. The expenses in this connection are, of course, very heavy, and owing to the somewhat unique nature of the Board's statutes, present the Board with a considerable bill which has to be borne by the revenues of the port. It is felt that notwithstanding the long period over which this statutory position has been maintained, steps should now be taken to amend it, and a Bill to this end, which has the support of shipowners, is being presented to Parliament this session. The board's officers have been actively considering for some time, in conjunction with fire officers, etc., what steps can be taken so as to reduce the danger of ship fires."

The accounts of the board for the year ended July 1 last show that income from rates and dues amounted to £5,126,082, compared with £5,188,386 for the previous 12 months, and the operational surplus was reduced from £2,229,238 to £1,827,310. After providing for interest, etc., and transferring £400,000 to Renewals and Depreciation Account and £100,000 to general reserve, the amount carried forward is £12,059 against £107,903 brought forward last year.

Coastal Protection

Review of Methods for Defence

By PER BRUUN
Technical University of Denmark.

(concluded from page 222)

Comparison Between the Different Types of Sea Walls.

As will appear from the discussion in the previous issue, breakwaters can be classed as

Vertical walls or sloping walls, and
Impermeable or permeable constructions.

There is a disagreement as to which type of structure is the better, the vertical or sloping wall. Generally, vertical walls should be used only where the subsoil is non-erodible or where the possibility of erosion is small, which is generally the case with inward-bent coasts and bays.

Sloping walls can be used where the subsoil is erodible. They should be constructed so that they are conducive as little as possible to erosion. Sloping walls have not been very popular in England, cf. (24) pp. 95—96 and (13) pp. 55—56, because, it is maintained, there is no visible difference of the beach at vertical walls and at sloping walls. There is not complete agreement on this question, see (25), and during the last 10 years several large sloping walls have been built, e.g. on the Channel-coast at Dymchurch and Pett Level, see above. The difference between the impermeable and the permeable construction is that of the percolation and the loss of energy involved. In consequence of percolation the energy-loss at the permeable construction will be greater than that at the corresponding impermeable construction, unless the latter is supplied with a special roughened surface, see below. This advantage is, however, nullified, when the water-volume of the waves is large in proportion to the volume of voids. The advantage of using permeable structures is especially great for slopes steeper than 1 on 1.5 which are subject to storm waves, i.e. waves with

$$\frac{Ho}{Lo} = \text{about } 0.04.$$

With slopes >1 on 1.5 the waves will break, and the advantage of using a permeable structure is decreased. The permeable structure has, however, one advantage over the impermeable one. viz. the structure, when subjected to severe wave action, is not prone to complete failure as it will follow a process of disintegration stone by stone rather than total collapse, and the damaged structure will be far easier to repair than the impermeable one, as one will only have to supplement the material.

Demands on a Breakwater.

As a breakwater must provide permanent protection against erosion, it must fulfil the following demands:

(1) The placement in the beach profile must be correct.

If a sea wall collapses, because it has been built so high, that a cliff is formed in front of the structure, a serious mistake has been made. Before constructing a sea wall, an exact investigation of the seasonal fluctuations of the beach must be carried out; the winter profile should govern the base depth.

(2) The sea wall should not be built where the waves break.

Waves, striking a jetty or a sea wall may be oscillating waves, waves that are breaking or broken waves. A jetty or a sea wall must be built so that breaking waves do not attack the structure, see (13) p. 181. Exceptions to the rule are certain types of sloping walls which are designed to produce wave-breaking in order to cause as much loss of energy as possible.

(3) The configuration must not increase the erosion in front of the wall.

The problem is the ordinary leeside problem at groynes and jetties. It is evident, that any erosion on the leeside of some projecting part of a sea wall is detrimental to the wall on the leeside of "the bastion," cf. (26) and (27) p. 91. As a general rule, a breakwater must never follow the shoreline exactly in a small-tongued coast, as the bases of the small tongues may become exposed to particularly heavy wave attack. It is suggested that a better solution would be to construct walls across the tongues, see (28) p. 339 where Fig. 21-22 show protective concrete walls across 15 m. wide, 30 m. deep in the chalk cliffs at Westgate in Kent. In clayey meadows, extending to the sea, e.g. in the marshes on the north side of the estuary of the Humber, oblong holes in the cliff often appear. These holes are constantly enlarged by waves and tide. At the Humber they are filled with lime-stone from Lincolnshire.

Structural rubbish can also be used, but it must be sorted during the placing.

Fig. 19. Wave screen at Pett Level.

(4) The sea wall must fulfil the following main conditions.

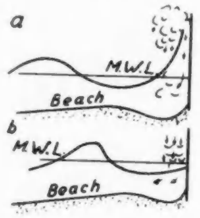
It must be stable. The problem is especially interesting, if the cliff consists of low shear strength clay. In that case, unless measures are not taken against possible slides, e.g. by establishing effective drainage, a sea wall might some day slide. It is therefore of great importance that the sea wall is drained in an effective manner. In general, drainage should be provided even under the monolithic type of concrete pavement.

The sea wall must be able to resist the wave attack and other forces.

When a sea wall is overturned this may be caused by hydrostatic pressure, wave force or attack from foreign bodies, especially when rubbish has been washed away from behind the structure. This applies especially to dykes and dams. The sea wall should be constructed so that it withstands hydrostatic force and wave force. Concerning wave force, and dimensioning for wave attack, the reader should consult (29) p. 218 and pp 235-242 or (30), Iribarren's dimensioning of rubble mounds (31) pp. 28-48, Minikin's diagram for breaking waves, and (32) Sainflou's diagram for unbroken waves. At the moment it is not possible to calculate exactly the wave force on sloping walls, even if by means of the characteristic-theory progress is made in the calculation of the uprush on a smooth slope. Therefore, the dimensioning of sloping walls, impermeable as well as permeable, depends on practical experience.

Wash-outs of the backfill caused by back-rush or overflowing water must be avoided. It often happens that a sea wall is damaged because the water striking the structure falls down behind it, washing away the backfill or damaging roads, etc. Measures against this

Coastal Protection—*continued*



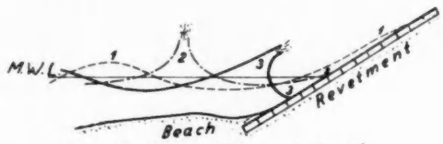


Fig. 20 (left). Effect of clapotis.

Fig. 21 (above). Effect of back-rush.

are, e.g. the use of a tight pavement behind the sea wall, see (33) pp. 26-27 or reduction of the uprush, a common practice in Holland.

A berm is sometimes used in order to absorb the force of the falling water cf. (13) pp. 63 and 74. A cornice or a small vertical wall at the upper end of the slope is often satisfactory, cf. (13) pp. 47-49, 63, and (33) p. 27. The uprush is reduced by arrangements of steps, sleepers, wave screens or prisms of concrete put down in the slope, see below.

The sea wall must not contribute to the erosion in front of the structure.

Sea walls should never be constructed on coasts subjected to continuous erosion at deep water; if so, they will soon be destroyed, see (5) and Fig. 21. Yet, a sea wall has often collapsed or been damaged as a consequence of erosion in front of the structure. Any impermeable wall put in a beach may have a destructive effect on the beach. Three different effects are possible, cf. the Figs. in (34) pp. 252-253 (Minikin).

(1) The effect of the clapotis in front of a vertical or a steep sloping wall, possibly reinforced by pressure of the water falling from the wave rise after impact, Fig. 20.

(2) The effect of the collision of the back-rush with the beach, see Figs. 21 and 22.

(3) The effect of reflection, see Figs. 21 and 23.

The effects (1), (2) and (3) appear together or in pairs. With vertical walls (1) + (3) appear; with vertical walls provided with a protective apron, a berm or a slope a combination of (1), (2) and (3) may occur, whereas with sloping walls only (2) and (3) appear, since (3) is usually due to (2).

Different experiments have been made with sea walls built in a beach. In the following, Reynolds investigations, cf. (35), Bagnolds investigations, cf. (1) and some investigations made in Copenhagen in 1949 are mentioned.

Reynolds noticed that there is a certain critical height for a beach in front of a vertical wall. When a beach is higher than a certain level it builds up, conversely, if it is below this level it will be eroded—in either case within certain limits.

Bagnolds corresponding investigations of beach profiles (6), with special reference to shingle beaches, proved that the erosion of the beach started as soon as the uprush reached the impermeable vertical or sloping wall, so that part of the backrush thereafter took place above the surface of the stones.

Experiments with beach profiles carried out in 1949 in the Hydraulic Laboratories in Copenhagen showed, that some wave energy is reflected from the beach. The reflection appeared by a formation of low waves in the sand bottom, where the wave length was $\frac{L}{2}$, L = the water-wave length. I shall not try to explain the reason why those waves arise, whereas the influence of the reflection on the littoral drift will be mentioned. As to the backrush, this represents reflected energy, and the less energy in the back-rush, the less will the backrush contribute to the reflection. In special cases the backrush might cause a wave to break, which otherwise would not have taken place. In general, however, it can undoubtedly be taken for granted, that the suitability of a sea wall can be measured by its energy-absorbing ability, i.e. the best sea wall is the one that gives the least reflection.

The Influence of Sea Walls on the Littoral Drift.

As mentioned earlier a systematic discussion of littoral drift problems as a whole is not possible, because the knowledge of the primary causes is insufficient.

The above-mentioned investigations made by Shields, Kalinske and Einstein give some reason to believe that the bed-load transportation—within a limited range—depends on the average water velocity raised to the 5th or 6th power, i.e. the shear stress in the 2.5th or 3rd power, see (2) pp. 794-800. In his newest paper "The Bed-load Function for Sediment Transportation in Open Channel Flows," Technical Bulletin No. 1026, September, 1950, from U.S. Department of Agriculture, Einstein has stated the "Bed-load Function For Sediment Transportation" for more unlimited use by hydrodynamic and statistical calculations based on several experiments.

With oscillating waves, the bottom velocity is

$$u = \frac{\pi H}{T \sinh \frac{2\pi d}{L}} \cos 2\pi \left(\frac{X}{L} - \frac{t}{T}\right),$$

L = wave length, T = wave period, d = water depth, H = wave height.

As the bed-load transportation depends upon the water velocity in about the 5th power, a smaller increase in the velocity will cause a considerable increase in the littoral drift. With 10 per cent. reflection of wave height, the maximum velocity at the bottom will be increased by 10 per cent. If, without reflection, the littoral drift is 1, the littoral drift with 10 per cent. reflection is increased by about 2 per cent. As a consequence of this, the bottom will be eroded. The level of the bottom, however, is not only determined by the shear stresses due to the oscillating wave action, but by a combination of wave action and currents, in connection with the possible addition of materials from the sides. Considering a storm wave; deep water wave height = 2 m., deep water wave length = 40 m. i.a. steepness ratio 0.05 and T = 5.1 sec., and provided that the bottom is stable at a maximum velocity of 1 m. per sec., this velocity will be found at a depth of 4.7 m. In Table 1, depths corresponding to the different reflection coefficients, are computed for a bottom velocity of 1 m. per sec. The increase in littoral drift at the different reflections is compared with the littoral drift without reflection.

As to the longshore current, this is weakened by a lowering of the bottom, but its effect upon the detachment of the sand particles will usually be small compared with that of the oscillating wave action.

Table 1. Bottom velocity 1 m./sec. with various reflection co-efficients, intensity of littoral drift.

Reflection factor	Bottom velocity 1 m/sec. in depth	Intensity of the littoral drift
0.0	4.7 m	1
0.3	6.2 m	about 1.6
0.6	7.5 m	about 4

It appears from the table that it is of great importance that the reflection is less than about 0.3.

Investigations Made in the Hydraulic Laboratory in Copenhagen.

The following results of investigations made in Copenhagen, 1949-1952, are instructive. The object of the investigations was to

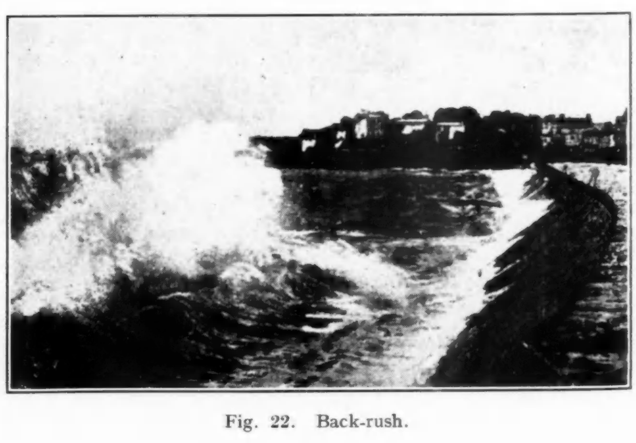


Fig. 22. Back-rush.

Coastal Protection—continued

find the best principle for the construction of an economical sea wall with as little reflection as possible.

Practical experience has proved that damage to sea walls will appear during storms and high water, and, consequently, under these conidtions a sea wall must prove its efficiency: therefore, the experiments were carried out under storm conditions.

Concerning the placing of the structure in the beach profile, the general rule is that the sea wall should be constructed where it can be built best and cheapest with the desired effect. Sea walls with a vertical or slightly sloping front should, as mentioned before, never be constructed on erodible coasts; they will at any time have to be placed so far away from the shoreline that they will never be subjected to unbroken or, especially breaking waves. A sloping wall must cause a loss of energy as large as possible, e.g. by causing the waves to break. The waves break at a depth of about 1.3 H_b, H_b being the wave height at the breaking. If a sloping wall is to be built on a coast consisting of erodible material, it is necessary to construct the wall so that the maximum effect of the waves bears upon the slope itself and under no circumstances on the bottom just in front of the structure, as in that case the structure might collapse through underscour. The revetment, therefore, must be made in such a way, that it is able to stand such action, and it should be as flexible as possible. On a coast consisting of less erodible material it is easier to select a construction. A berm, built in a sea wall should be placed where it causes the greatest loss of energy.

In "Annual Inspection," 1949, Rother and Jury's Gut Catchment Board, Dobbie writes the following about the placing of the berm in the sea wall at Pett Level. "In a part of the wall which, although fulfilling a very useful function, is not so essential as the remainder, the berm is at the highest level so that the first shock of wave action is taken by the clay and concrete toe, backed by the whole weight of the wall, the troublesome top of the wave runs on over the berm, losing energy, and is finally stopped by the back wall."

The height of the berm must be such as to effect the greatest possible energy-loss, whether it is smooth or roughened. Its width will have to be reasonable and economical. If the sea wall is roughened corresponding to storm conditions, this roughness must be arranged so that it does no harm under more normal water and wave conditions. There may be two degrees of roughness, a big and a small one, with open spaces between the big roughness (e.g. sleepers) and the slope, so that the uprush during more normal wave conditions may partly pass under the big roughness. Finally, the uprush will have to be as small as possible. The measures against the reflection may under no circumstances increase the turbulence in the back-rush at the intersection of the slope and the normal beach.

Below are given a few examples on the experiments carried out. The tests refer to the actual water level and wave conditions. The results have a fundamental character.

Fig. 24 shows the different experimental objects with dimensions stated.

The tests were carried out in a 16 m. long, 0.5 m. wide canal

Fig. 23. Reflection.

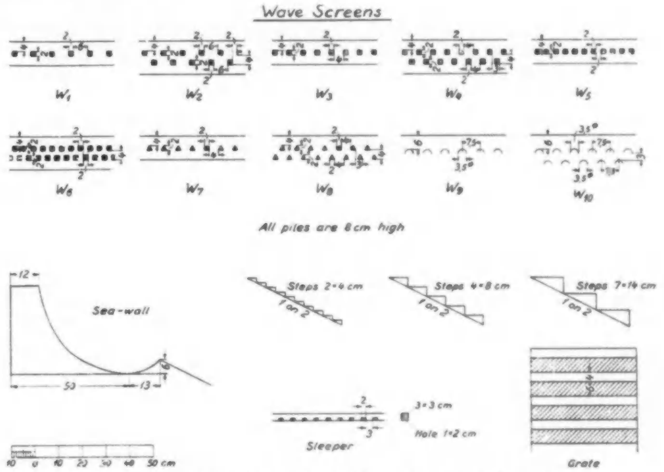


Fig. 24. Objects used in laboratory experiments.

with a water depth of about 0.6 m. The deep water wave height Ho = 12 cm., the deep water wave length Lo = 266 cm., the steepness ratio $\frac{Ho}{Lo} = 0.045$. The scale was 1 : 20, corresponding to conditions in the North Sea. It was assumed that there is extraordinarily high water = Ho, and also erosion in front of the breakwater of extraordinary dimensions = 3/4 Ho.

Fig. 25 shows a longitudinal section in the test-canal, in the end of which the breakwater was built in a beach with slope 1 on 12, a usual slope at beaches built of rough material (shingle). A cross-section of a berm-wall and arrangements for producing solitary waves are shown. In experiments with berm-walls was the berm width 30 cm. = 1/9 L_0, the upper slope is s_1, the lower slope is s_2. The reflection is defined as

$$\frac{\text{height of the 2-3 highest waves}}{\text{height of the incoming wave}}$$

The height of the uprush is defined as the height of the 2-3 highest uprushes.

Measuring of the reflection with solitary waves was made by oscillograph, and in the tests with oscillating waves by photography during a period limited by the starting of the wave machine and the reflection from the flap.

Some preliminary experiments with varying berm-height showed that a berm—under the given conditions—gave the least reflection when it was placed at the same height as, or a little higher than, the highest water level. Similar experiments with a berm-width varying between 1/8 Lo and 1/4 Lo proved that the widest berm gives the least reflection, but the difference in reflection for berm-width 1/8 Lo and 1/4 Lo for water level 1/10 Ho below berm height was only about 5 per cent. It looks as if the reflection is increased a little when the berm is given a forward slope, which, however, is practical in respect of the run-off of the water. The following gives an idea of the results. For more detailed information the reader should consult (26).

(1) **Smooth unbroken slope, slope with a roughness.** Three different types of sleepers were used; a 1 by 2 cm. sleeper raised 1 cm. above the slope; a 3 by 3 sleeper provided with holes and also a sleeper compounded of 2 separate sleepers, 3 by 3 cm., forming one 3 by 6 cm. sleeper. The space between the sleepers was everywhere 15 cm.

(a) the sleepers have little effect at slope 1 on 1.

(b) at slope 1 on 2 the sleepers have a rather strong effect; at slope 1 on 3 less effect.

(c) wide sleepers seem to be more advantageous than narrow ones.

(d) the importance of the holes in the sleeper is as follows:

During the wave attack the structure is partly filled with water. The water, accumulating behind the sleepers. must run off, otherwise it will take up room when the following wave arrives, causing a stronger backrush, stronger reflection and an increased possibility of erosion of the beach than if the structure is able to retain

Coastal Protection—continued

water, and then release it more slowly out into the trough of the sea. The decrease in reflection, however, was difficult to demonstrate with a 1 cm. hole below the sleepers; but with a 2 cm. hole the decrease became perceptible (about 5 per cent.). On the other hand, the sleeper was raised too much for the stability. The space has another purpose. If the height of the water is more normal, and the wave height smaller, the sleepers may not serve as vertical walls, which would increase the reflection. Smaller waves or uprush from such waves must, therefore, wholly or partly, pass underneath the sleeper. The sleepers may not be placed so that they cause an increase of the turbulence in the area about the intersection of the slope and the normal beach. Here the slope should be smooth, possibly supplied with steps or minor roughness.

(e) Results from experiments with solitary waves, together with the uprush give similar results.

(2) **Experiments with wave-screens, W_7, W_8, W_9 and W_{10}.** Concerning the objects used in experiments, see Fig. 24.

(a) at slope 1 on 2 on s_2 the reflection is to some extent reduced in proportion to the smooth structure. In general, W_9 and W_{10} are best, but W_7 and W_8 are almost as good. These four W-s-types are formed in such a way that the water will pass more easily behind them than in the opposite direction, cf. Fig. 24, in which a "water-pad" is formed on the berm. Turning W_{10} 180° will cause a reflection as small or smaller than at W_{10}, but a very strong wave rise after impact appears, i.e. the piles will be exposed to a violent force. Whether the slope, s_1, is 1 on 1, 1 on 2 or 1 on 3, is of no consequence, seeing that little momentum remains in the uprush behind the W-s.

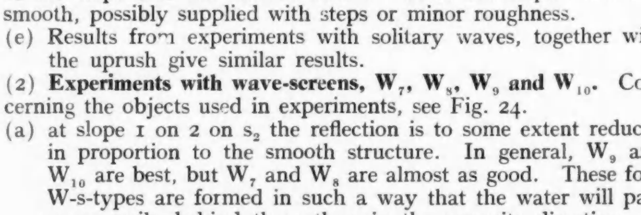


Fig. 25. The test canal.

(b) at slope 1 on 3 on s_2 the reflection is also reduced slightly, but less than at slope 1 on 2. It is unimportant whether the slope on s_1 is 1 on 1, 1 on 2 or 1 on 3.

(c) the uprush is reduced slightly in proportion to the smooth structure—especially at slope 1 on 2 on s_2.

(d) altogether, the importance of the W-s is not convincing at the actual water and wave conditions; yet, the height of the uprush is reduced.

(3) **Steps on the berm-wall; comparison with a smooth wall.** The usual three different step-dimensions, cf. Fig. 24, are used on both s_1 and s_2, which have slope 1 on 2.

(a) steps on s_1 do not affect the reflection.

(b) steps on s_2 give the same reflection for small steps of 2 by 4 cm., less reflection for steps of 4 by 8 cm. and a little more reflection for 7 by 14 cm. steps.

(c) experiments with solitary waves with steps on s_1 always give less reflection, especially for steps 7 by 14 cm.

(d) the steps always reduce the height of the uprush.

(e) altogether, the steps are unimportant to the decrease of the reflection under the actual conditions; nevertheless, they reduce the height of the uprush. The steps in the breakwater at Agger, cf. Fig. 17, probably have been quite ineffective to the reflection, and they have not weakened the uprush sufficiently.

(4) **Berm-wall with stone pavement (rubble blanket).** An 8 cm. layer of stones 4-6 cm., i.e. about 2 layers, has been used.

The level of the berm is at mean water level.

(a) the stones cause a considerable decrease of the reflection, especially at slope 1 on 1 on s_2.

(b) the berm only reduces the reflection by 5—10 per cent. as compared with the corresponding structure with an unbroken slope with slope 1 on 2 and 1 on 3, with slope 1 on 1 yet about 25 per cent.

(c) the slope on s_1 is unimportant.

(d) a few tests with solitary waves give the same result as mentioned under item a, but not so markedly.

(e) the uprush is reduced considerably by the permeable structure.

(f) a few tests showed that the upper part of a rubble mound with slope 1 on 2 may be omitted, which is an obvious advantage.

(5) **Sea wall of normal cross section.** In the above some drawbacks, especially of sea walls, are mentioned, viz.:

(a) tendency to erosion behind the structure due to falling water and uprush.

(b) tendency to erosion in front of the structure due to falling water, backrush and reflection.

Measures against (a) were: a high wall, use of a wave screen, introduction of a berm in the wall or protection of the area behind the wall by a tight cover.

Measures against (b) were: a protective apron in front of the wall — often to a considerable extent — groyne construction and/or artificial replenishment of sand.

The result of experiments with the sea wall shown in Fig. 24, which has been provided partly with a stilling-basin at the foot, partly with roughness consisting of 2 by 2 cm. steps (1/6 Ho). The experiments were made with berm levels 60 cm. and 66 cm. at the base of the wall.

(a) the reflection has been considerably reduced by the building of a stilling-basin at the foot of the wall. The reflection is least with a berm height of 66 cm.

(b) tests with a solitary wave with the water level at 60 cm. gave the same result concerning the effect of stilling-basin.

(c) the uprush is reduced essentially.

(d) tests at berm level 66 cm. with 2 by 2 cm. steps = 1/6 Ho (or about 0.4 m. for conditions in the North Sea) gave the same reflection as without steps, but less uprush.

(e) from the above discussion it appears that the bottom protection in front of the wall, "the protective apron," should be made as a stilling-basin, whereas the pavement of the wall should be laid in steps, and the wall should be supplied with a "wave-nose."

The final cross section must naturally depend on special investigations in each individual case.

Breakwaters

In coastal engineering isolated breakwaters have been used especially in Italy, Spain and the United States, see (23) and (36). They are expensive but effective. Breakwaters in connection with groynes, according to the above, are used to form T-groynes, Angular groynes and Z-groynes.

Artificial Nourishment of Beaches

Artificial nourishment of beaches is an American idea—and there is some reason to believe that much coastal protection in future will be carried out in this way because there is a growing recognition of the fact that prevention of erosion by means of protective structures very often is a dangerous practice, see (37), inasmuch as in many cases such protection is obtained by the production of an ever expanding problem area because of the leeside erosion. Artificial nourishment, on the other hand, is of benefit not only to the shore upon which it is placed but to adjoining shores as well.

As pointed out by Eaton and Hall, see (11) and (37), the method, even if it has been employed without a complete understanding of all factors controlling an ideal installation, has given good results.

When the quantitative deficiency in the material supply in the area considered and the predominant direction of the littoral drift are determined the problem one is faced with is that of selecting a suitable beach material. The selection of a material of the proper gradation to produce the required slope of the beach at the present time can only be determined by analysing the sand taken from a beach in the surrounding area, which has a similar orientation and is acted upon by the same wave forces. Sand selected for artificial nourishment should ideally contain the same gradation of materials as those found on the beach to be nourished, if the original beach slope is to be maintained. Material of coarser characteristics may be expected to produce a steeper beach than normal. Material finer than that occupying the natural beach, when exposed on the surface, will move seaward to a depth compatible with its size, see (37) p. 4.

There are four types of artificial nourishment:

(a) the offshore dumping method, the stockpiling method, the continuous-supply method, and the direct placement method.

The offshore dumping method was tried at Long Branch, New

Coastal Protection—continued

Jersey and at Santa Barbara, California. In both cases dredged sand was deposited in about 20-ft. of water (MLLW). The results, however, were not good, but this may be due to unfavourable conditions.

The stockpile method was first tried at Santa Barbara, California, and has been in successful operation since 1938. The problem at Santa Barbara was created by the construction of a breakwater in 1929 which blocked the littoral drift. In 1938 a co-operative project was developed at the recommendation of the Beach Erosion Board, providing for establishment of a stockpile beach fill along 4,000-ft. of shore downdrift from the harbour to be initially filled and periodically maintained with material dredged from the harbour. Since 1938, replenishment has been accomplished at two or three years' intervals. The average rate of artificial nourishment has been 300,000 cubic yards a year and is accomplished with pipe line dredging equipment.

The continuous-nourishment method is, for instance, tried at Salina Cruz, Mexico, a harbour on a littoral drift coast, see (38), pp. 177-186. Six suction pipes run by special derricks were arranged on the updrift side of the harbour, and sand was pumped to the leeside.

One of the best examples of continuous nourishment to a beach downdrift from an inlet is the sand by-passing plant at South Lake Worth Inlet, Florida. South Lake Worth Inlet is located on the east coast of Florida near the southern limit of Lake Worth, which separates the mainland from the sand barrier on which the town of Palm Beach is located. The inlet is secured by two jetties about 250-ft. long. Due to abundant littoral drift from north to south in this area, the littoral reservoir formed by the northern jetty was quickly filled, and sand was carried around the jetty and into the inlet.

A pumping plant was installed in 1937 on the northern jetty, see (29), pp. 320-325. The plant consisted in the main of an 8-in. suction line and a 6-in. centrifugal pump. During the four years between 1938-1941 beach material was pumped past the inlet at the rate of about 48,000 cubic yards per year. The result was that the beach on the leeside was restored.

The direct placement method differs from the stockpile method in that the fill is completed at one time over the entire shore to be protected.

This type of beach rehabilitation was used at Atlantic City, New Jersey, in 1948, to quickly restore the ocean beach. The beaches were replenished with sand moved across Absecon Inlet. In the summer of 1948 700,000 cubic yards were placed on the beach off Atlantic City over 6,000-ft. length.

Conclusion

From the above it seems as if coastal protection in future will include:

(1) Structures consisting of specially designed groups of groynes or sea walls.

(2) Artificial nourishment.

REFERENCES

24 Duvivier, J. (1949), Report to the XVIIth International Navigation Congress, SII, C1, pp. 85-103.

25 Du-Platt-Taylor (1940), The Prevention of Coast Erosion, Journal Inst. Civil Eng. 1940/1941, pp. 53-60.

26 Bruun, Per (1953), Report to the XVIIIth International Navigation Congress, SII, QI.

27 Minikin, R. R. (1950), Coast Erosion: The Dock and Harbour Authority, Vol. XXXI, No. 357, pp. 91-94.

28 Minikin, R. R. (1950), Coast Erosion: The Dock and Harbour Authority, Vol. XXXI, No. 353, pp. 335-339.

29 Council on Wave Research (1951), Coastal Engineering No. 1, By-passing Sand at South Lake Worth Inlet, Florida, paper by J. Caldwel.

30 Iribarren Cavanilles (1950), Generalization of the Formula for Calculation of Rock Fill Dikes and Verification of its Coefficients: Revista de Obras Publicas Mayo de 1950; see also Coastal Engineering No. 1, pp. 217-219 and 237-241.

31 Minikin, R. R. (1950), Winds, Waves and Maritime Structures, Studies in Harbour Making and in Protection of Coasts: Charles Griffin and Co., Ltd., London.

32 Sainflou, G. (1928), Essai Sur Les Digues Maritimes Verticales, Annales Des Ponts Et Chausées, Parti Technique, Vol. 98, No. IV, pp. 5-48.

33 de Rouville, A. (1951), Renseignments Et Réflexion Sur des Ouvrages De Défense Des Côtes: Conférences Du Centre De Recherches Et D'Etudes Océanographiques, Conf. No. 2, "Problème de Défense des Côtes."

34 Minikin, R. R. (1949), Coast Protection: The Dock and Harbour Authority, Vol. XXIX, No. 340, pp. 251-256.

35 Reynolds, K. C. (1933), Investigation of Wave-action on Sea Walls by the Use of Models: Transactions American Geophysical Union, Vol. 14, pp. 512-519.

36 Vera, Isla and Acena (1949), Report to the XVIIth International Navigation Congress, SII, C1, pp. 21-44.

37 Beach Erosion Board (1952), Technical Memorandum No. 29, Corps of Engineers, Washington, D.C.

38 Council on Wave Research (1952), Coastal Engineering No. 2, Sand By-passing Plant at Salina Cruz, Mexico, paper by C. Rolland.

Customs and Excise in British Ports

Operation of the Service at Southampton*

Customs Authorities play an important part in the organisation of a port and are Government Departments whose principal duties are the collection of Customs Revenue and the prevention of smuggling to avoid payment of customs duties.

In the United Kingdom the administration of the Customs and Excise is vested in a Board of Commissioners presided over by a Chairman, and includes a Deputy Chairman and three Commissioners, all of whom are Civil Servants.

The organisation is divided into two parts—the headquarters and ex-headquarters. The latter section, with which a port authority usually works, operates over the whole country and consists of two separate services. The first is that responsible for the actual assessment and collection of Customs duties—the Outdoor Service, while the second is responsible for promotion of smuggling—the Waterguard.

The Outdoor Service is geographically divided into Collections each of which consists of a number of districts. The officer in charge of each one is the District Surveyor who, in certain cases, may be regarded as the " opposite number " to the Dock Superintendent of a port authority's dock system. Districts are divided further into stations, controlled by a Customs Officer assisted by Customs Watchers. A station may cover a large portion of a dock area or a small area such as a shipberth with its quay and transit shed or even a single shed or warehouse, depending upon the functions to be performed.

The Waterguard or Preventive Service covers, in the United Kingdom, 15 geographical divisions each controlled by a Waterguard Superintendent. Each division is divided into districts under a Waterguard Surveyor and each district into stations each operated by a Preventive Officer. Some stations are also organised into groups, under Chief Preventive Officers.

Port of Southampton Organisation.

The Customs and Excise Service at the Port of Southampton is a typical example of the organisation and functioning of the Service at a British port.

The uniformed officials who deal with passengers and their baggage are the Waterguard branch of the Customs and Excise Department. They operate under the supervision of Chief Preventive Officers and the control of the Waterguard Superintendent.

The Waterguard or Preventive Officers are the first revenue guard against the smuggling of dutiable or prohibited goods. They exercise control over ships, aircraft and their crews and passengers; board ships and aircraft on arrival from overseas to search for concealed contraband, and deal with crews' effects and the ships' surplus dutiable stores. During their stay in port all ships are kept under continuous watch by the Waterguard Officers, Preventive Officers supervise the shipment of duty free stores for use on a foreign voyage, and mess and canteen stores on H.M. Ships.

The whole of Southampton Docks and the expanse of Southampton Water must be covered and ships met and boarded as necessary. For this work, in addition to the Waterguard Staff stationed

*Based on article in the August 1953 issue of the Southampton Shipping Guide.

Customs and Excise in British Ports—*continued*

at 29 Berth, the Ocean Terminal and the New Docks, Preventive Officers patrol Southampton Water in Revenue launches and visit vessels lying at Fawley and the Hamble River and elsewhere in Southampton Water. Even the small craft visiting the neighbourhood do not escape the watchful eyes of the Customs Coast Preventive Staff and Launch Services.

By experience and training members of the Waterguard service obtain a considerable knowledge of human nature which enables them to detect would-be smugglers with considerable ability.

Duties performed by the Waterguard, in addition to the prevention of smuggling, are the enforcement of Public Health regulations for the Minister of Health, control of the landing of live animals and plants for the Miinstry of Agriculture and Fisheries, the measurement of deck cargoes for the Board of Trade, and the control of imported arms, ammunition, drugs, etc., for the Home Office.

A branch of the Customs and Excise Department operating in Southampton Docks which is not so prominently in the public eye is the Customs "Outdoor Service." This branch is staffed by "Officers of Customs and Excise," who do not wear uniforms. They carry out their duties mainly in the Transit Sheds in the

Photo by courtesy of British Transport Commission

Customs Examination Hall, Ocean Terminal, Southampton.

Docks, but ships discharging or loading cargo at wharves outside the docks also come under their control.

Their duty is to assess and collect the Customs and Excise revenue and prevent evasion of payment of duties, including Purchase Tax. They examine the merchandise which arrives from all parts of the world. and ensure that all goods brought by an importing ship or aircraft are properly accounted for and not released until duty has been paid or secured. They maintain revenue supervision over the shipment or cargo exported from bonded warehouses or on drawback, and see that import and export prohibitions and restrictions are not infringed.

The bonded warehouses in Southampton Docks in which dutiable goods may be deposited pending payment of duty or re-exportation are supervised by these officers, who allow and control permissible "operations" on goods whilst in warehouse.

The Parcel Post Depot, where goods imported by post are dealt with, and the Queen's Warehouse, in which seized and detained goods are deposited, are under the control of Officers of Customs and Excise.

"Watchers," who patrol quays and warehouses and take charge of dutiable goods until they are in a place of approved security, are supervised by the Officers.

In the course of their duties these Officers (usually known as the "Landing Officers" or "Shipping Officers") gauge casks of wines and spirits and assess the alcoholic strength of their contents. They weigh goods, such as tobacco, sugar, etc., and satisfy themselves as to the value of goods liable to *ad valorem* duty. This work calls for expert knowledge of goods, their values, and of the practices of the trades concerned with the marketing of the goods.

Officers are based on "Stations" in various parts of the Docks, the "Stations" being grouped in "Districts" in charge of Surveyors, who are responsible for the general supervision of the work and staff of the Districts. There are three such Districts in the port, two in the Old Docks and one in the New Docks.

The importance of this branch of the Customs and Excise Department will be realised when it is stated that it was responsible for approximately £70 million of revenue in Southampton in 1952.

Additionally to the staffs employed in the docks and on the quays are the officials stationed at the Custom House. It is here that the master of every ship from foreign parts delivers the Report of his ship and its cargo, and obtains "Clearance" or permission to depart on a foreign voyage. The master of every vessel is required by law to answer any questions relating to his ship, its cargo and its voyage, and this interrogation is carried out by the Custom House Staff.

Importers and Exporters of goods deliver at the Custom House the officially prescribed "entries," invoices, certificates of origin and other documents which are required to secure the importation or exportation of their goods. These documents are scrutinised and examined by the Custom House officials to ensure that goods are properly described and classified as required by the Customs and Excise Import and Export List and Tariff, that values are correctly assessed and that declarations of origin and destination, etc., are properly given.

It is at the Custom House that the actual payment of Customs duties is made and subsequently paid into the Exchequer. Statistics of the Import and Export trade of the port of Southampton are compiled by the Custom House staff and are sent to the Customs and Excise Statistical Office, London, for inclusion in the "Board of Trade Returns." Here also are kept records of all Customs (including staff) matters both current and of historical interest relating to the Port of Southampton.

The administration of the Customs Service in the Port of Southampton is in the hands of the Collector who is the local representative of the Board of Customs and Excise. He is assisted by two Assistant Collectors. Through these officials the Board are kept in touch with local developments which affect the Customs and Excise Department. An important item of their duties is to ensure that Customs staff and facilities are adequate to the needs of the trade of the port; and that good relations are maintained between the Department and shipping companies, dock authorities, importers and exporters. In addition to his duties as a Revenue collecting official the Collector is the Registrar of British Ships and Receiver of Wreck for the Port of Southampton.

Whilst the duties of the Customs and Excise Department are of necessity restrictive in character, all its officials seek, by courteous and efficient performance of their duties, to facilitate the work of the various shipping and business interests of the great port of Southampton. In this they invariably have the co-operation of the Docks and Harbour authorities and all users of the port.

International Advisory Commission for Works of the Suez Canal.

The Suez Canal Company set up in 1884 a "Commission Consultative Internationale des Travaux" which first met at Paris in 1887 and has continued to meet regularly since then—apart from the two war intervals. The Commission advises the Canal Company on maintenance and improvement of the Canal, and at present consists of sixteen members selected from Engineers of France, Belgium, Egypt, the United States, Great Britain, Italy, Norway and the Netherlands. The British representatives until recently have been Sir Athol Anderson, K.C.B., former Civil Engineer-in-Chief of the Admiralty, Sir Arthur Whitaker, K.C.B., Civil Engineer-in-Chief of the Admiralty and Vice-President of the Institution of Civil Engineers, and Sir Cyril Kirkpatrick, former Chief Engineer of the Port of London and an ex-President of the Institution of Civil Engineers.

Sir Cyril Kirkpatrick, after many years distinguished service, has recently decided to resign from the Commission owing, unfortunately, to ill health, and Mr. John E. G. Palmer has been appointed a member of the Commission. Mr. Palmer is a Partner in the Westminster firm of Consulting Engineers, Rendel, Palmer and Tritton; he is the son of the late Sir Frederick Palmer, K.C.M.G., who was a member of the International Advisory Commission for a number of years prior to his death in 1934.

The Chain of Rocks Canal

Improvement to Mississippi River System

By COL. F. E. RESSEGIEU, District Engineer, U.S.A. Corps of Engineers.

North of St. Louis three great waterways converge and feed their commerce into the middle Mississippi River. The upper Mississippi, with a minimum 9-ft. channel as far north as Minneapolis assured by 26 locks and dams, has an ever increasing commerce, and in 1951 carried approximately 12,000,000 tons. The Illinois River, also a 9-ft. waterway, is the connecting link between the Great Lakes and the entire Mississippi and Ohio River systems, and carried about 17,000,000 tons in 1951. The Missouri River, with a 9-ft. channel under construction to Sioux City, 760 miles from its mouth, is in the development stage and has a vast potential. Just below the convergence of these waterways, impeding and at times blocking their full access to the lower Mississippi River, is the reach known as the Chain of Rocks, the last great bottleneck to the full usefulness of the system.

Mention of the Chain of Rocks to a river man brings a vivid picture of the jagged rock ledges which jut out into the river from the west bank a few miles north of St. Louis, and which have made this treacherous stretch of river famous for many years. The rock ledges limit the depth of channel which can be maintained during low water periods since of course they are not susceptible to ordinary dredging operations. Thus, the full value of the 9-ft. channel above and below the spot is lost. In times of higher water, also, the ledges, which bring about a sharp increase in river slope, cause a great increase in turbulence and river velocity. This delays upstream bound tows and has caused many marine accidents. It frequently necessitates the breaking up of large tows and as many as three trips through the 7-mile stretch with one of two barges at a time.

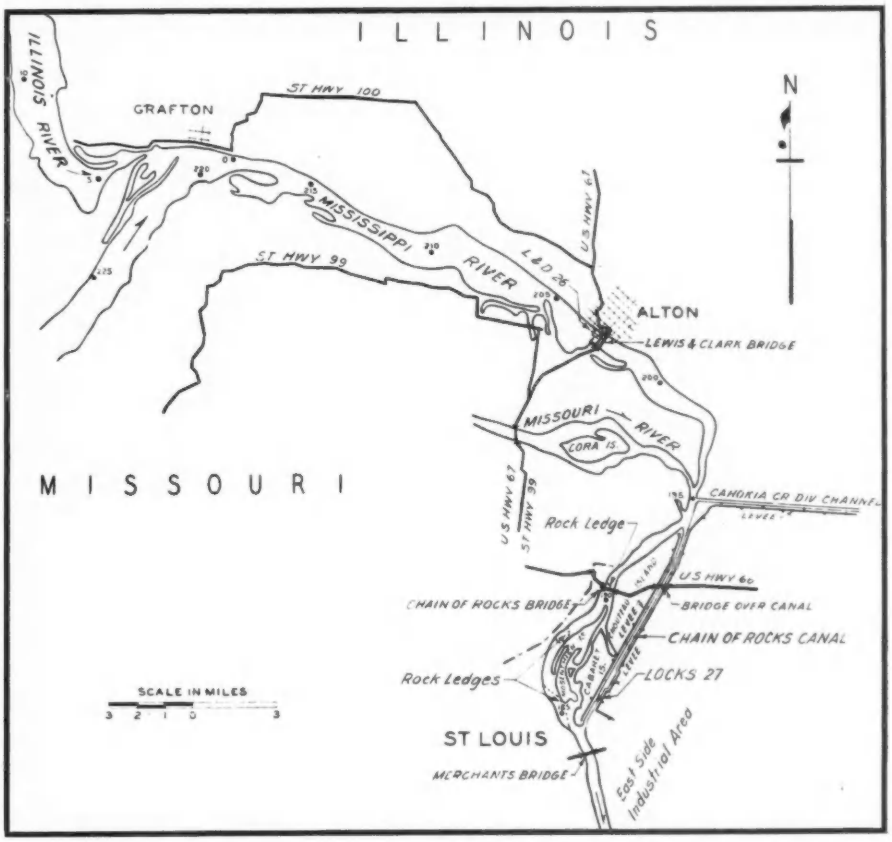
To by-pass this treacherous bottleneck, there has been built the 8-mile Chain of Rocks canal which, with its attendant locks, provides a dependable 9-ft. channel connecting the upper and middle Mississippi River systems.

The condition at Chain of Rocks is not new and neither is the idea of attempting to remedy the condition by the use of a canal. Other remedies have been considered such as the removal of the rock by blasting and dredging, but these were discarded as impractical. A canal was first proposed prior to 1900 and was seriously considered in 1904 in a study prepared by the U.S. Army Corps of Engineers, under whose jurisdiction river and harbour improvements are made. A report by the Corps in 1938 recommended a canal with locks in Illinois at the present site, and this construction was authorized by the Congress in 1945.

The principal features in the improvement consist of a canal 8.3 miles long, with upper entrance just below the mouth of the Missouri River and lower entrance above the Merchants Bridge, connecting St. Louis with Granite City, Illinois. Navigation locks have been built about 6,000 feet above the the lower entrance to the canal. Other features include the construction of a bridge to carry U.S. Highway 66 over the canal, relocation of water, gas, oil pipelines, and telephone and telegraph power lines, the protection of the canal banks with riprap, and the installation of underseepage relief wells. The project will cost approximately $10,000,000.

lock 110-ft. by 1,200-ft., and an auxiliary lock 110-ft. by 600-ft. The locks, of reinforced concrete, are founded on limestone about 70-ft. below natural ground surface, the walls of the main lock being 92-ft. high. The east and west walls have generally a bottom width of 45-ft., varying up to 51-ft., while the intermediate wall is 40-ft. wide. Galleries are provided in the walls for easy access to operating machinery. Both locks can be completely unwatered for repairs or inspection by means of bulkheads upstream of the upper gates and downstream of the lower gates. The upper gate sills are at elevation 374, providing about 14-ft. depth at extreme low water. The lower gate sills are at elevation 360, providing almost 17-ft. navigable depth at extreme low water.

The upper lock gates are an unusual part



Plan showing position of Chain of Rocks Canal

The Locks.

Perhaps the most interesting feature of improvement is the locks. During early design stages it was proposed that a standard 110-ft. by 600-ft. main lock and only the upper gate bay of a 110-ft. by 360-ft. auxiliary lock be built, but studies of river traffic prior to actual preparation of plans and specifications indicated the need for a longer lock. The present trend in river traffic is to push along, compactly integrated tows with small but powerful towboats. It would have been short-sighted not to build a modern improvement with provisions for future navigation requirements. Consequently, it was decided to provide a main

of the design of these locks. In the process of studying various designs, it became evident that large quantities of water and ice might have to be passed through the main lock, and since it is impracticable to operate mitre gates against an appreciable head of water, a type of gate that could be operated to pass such flows had to be provided. Tainter, roller, and sector gates were considered but were found to be either impracticable or too costly. The upper lock gates are of an ingenious and unique design. The lower leaf operates as a movable mitre sill. There is an upper flap that participates in the normal lock filling operation and also serves to extend the gate above high water

The Chain of Rocks Canal—continued

View of lock, Chain of Rocks canal. In the background is the City of St. Louis.

in flood times. High water flows can be controlled to avoid channel deterioration. Ice and drift can readily be passed through the lock.

Each leaf consists of a series of horizontal steel girders covered on the upstream side with steel plates and is 30-ft. high and 115-ft. in length. The upper or operating leaf weighs about 270 tons. Each leaf is counter weighted and electrically operated by gate machinery with synchronising motors. The operating leaf is provided with a suitable crest to pass ice and flows from the canal to a depth of 10-ft.

The downstream gates of the main lock are mitre gates similar to those provided at other locks, except for their large size, each leaf being 61-ft. wide and 72-ft. high. They are horizontally framed, weighing 200 tons, and operate much like an ordinary door. To span the locks just below the upstream gates, a light-weight lift bridge 6-ft. wide has been provided. The bridge is submerged for passage of boats.

Inasmuch as the main lock has twice the area of the usual 600 ft. lock to be found on the Upper Mississippi River, special treatment of the filling and emptying system was necessary in order to hold the time of filling the lock to a reasonable period. It was also important to limit the velocity of flow in the canal above and below the locks resulting from lock operations, and to reduce turbulence in the lock. To work out this problem, a model of the 1200-ft. lock and its approaches was set up in the hydraulics laboratory at the University of Iowa. Model tests indicated the following solution, which was adopted. Two separate intake structures, one leading to the culvert in the east wall and the other to a similar culvert in the intermediate wall, have been provided in the upper sills. Water passes from the intakes to 14- by 15.5-ft. culverts contained in the base and extending the full length of each lock wall. From these culverts, ports connect with the lock chamber just above bedrock. The low elevation of the ports, and the fact that the ports are so placed that jets from opposite walls are not opposing, result in very little turbulence within the lock chamber during filling operations. Discharge from the locks is through a diffuser system immediately below the downstream gates. The time of filling the lock at maximum difference of water surface elevation of 21-ft. between upper and lower canals is about nine minutes. However, filling can be speeded by supplementing flow through the culverts with flow over the top of the vertical lift gate. Under maximum inflow conditions, average velocities are about 1 to 1-1/2-ft. per second in the upper approach channel and about 2-1/2-ft. per second in the lower approach channel.

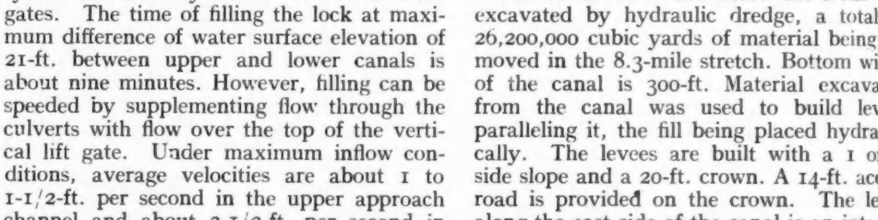
Discharge from the locks is accomplished through a diffuser system immediately below the downstream gates. During discharge water enters ports along the lock wall and is carried by culverts into discharge diffusers at the lower end of the lock. These diffusers are unique in that the water is discharged over a large area and in such a manner that turbulence is held to a minimum so that the energy of the water is dissipated harmlessly. If the energy of the water were not removed before it reached the canal bed, scour of the bottom of the canal might occur. If excess surface turbulence existed, small boats in the area would be endangered.

This type of discharge is accomplished by channelling the water into parallel tunnels outside the locks. These small tunnels have openings in the sides, staggered so that no two are directly opposite. The water rushing from one opening does not interfere with the water coming from an adjacent tunnel. The water is then able to move smoothly from the openings. The great number of these openings allows the energy of the discharging water to be spent over a large area instead of one or two isolated spots. The net result is a smooth, quiet discharge from the locks.

Construction of the locks began in July, 1947, and they were completed and opened to traffic in May, 1953.

The Canal

The canal above and below the locks was excavated by hydraulic dredge, a total of 26,200,000 cubic yards of material being removed in the 8.3-mile stretch. Bottom width of the canal is 300-ft. Material excavated from the canal was used to build levees paralleling it, the fill being placed hydraulically. The levees are built with a 1 on 3 side slope and a 20-ft. crown. A 14-ft. access road is provided on the crown. The levee along the east side of the canal is an integral element in the protection system of the great East Side industrial area against the maximum flood of record on the Mississippi River. Both banks of the canal for its entire length are being protected from scour by



Downstream view of new Chain of Rocks lock at entrance to canal. The mitre gates, now closed, fit into recesses in each side of wall. Walkaway bridge in foreground provides access to control house (right) for auxiliary lock. Bridge submerges during lockage to permit shipping to pass over it.

The Chain of Rocks Canal—continued

the placement of bank paving, consisting of a 12-in. layer of open hearth slag.

Immediately above the locks, and adjacent to Granite City, Illinois, the canal was widened to a bottom width of 700-ft. for a distance of about 7,000-ft. This widening was done for the purpose of balancing borrow and fill, that is, to procure material for the adjacent levees. It was also intended to provide a potential harbour site for the Tri-Cities industrial area. Already a portion of this harbour area has been leased from the United States by a Missouri-Illinois bi-state agency, and construction of harbour facilities is under way. It is expected that these facilities will be available and in use in the near future.

The canal entrances have been under study since inception of the improvement because of the problem of siltation. With regard to the upper entrance, a model study was performed at the Waterways Experiment Station of the Corps of Engineers at Vicksburg, Mississippi, to determine the extent of silting that might be expected. The results of this study indicated that silting would be minor and would be confined to the upper one mile of the canal. This is true even though the upper entrance of the canal lies below the mouth of the Missouri River, since the normally muddy waters of the Missouri do not mix with the clear Mississippi water for several miles downstream from the mouth. The lower entrance to the canal presents a different problem. Indications are that, at medium high water, the normal flow of the river results in the formation of a sand bar impeding entrance to the canal. Consequently, another model study was conducted by the Waterways Experiment Station at Vicksburg to determine what steps should be taken to prevent siltation of the lower entrance to the canal. The remedial work determined by the model study consists of constructing a stone dike 400-ft. long, normal to the west side of Cabaret Island, and about 300-ft. upstream from its lower end, with a trailer of stone extending 2,400-ft. downstream from the outer end of the 400-ft. dike, and approximately parallel to the canal at its lower entrance; thus, in effect, extending the canal downstream about 2,100-ft. Necessary bank revetment will be placed to prevent scour of the canal banks.

Incidental to the construction of the canal has been the installation of 200 underseepage relief walls and some impounding levees landward of the east canal levee, to relieve hydrostatic pressure due to the head of water in the canal, and insure the safety of the levees in times of extreme flood.

Radio telephone facilities have been installed in the main control house at the Chain of Rocks lock. It is expected that, by this means, the control of traffic can be simplified and the passage of tows expedited when river traffic is heavy.

With the opening early this year of the Chain of Rocks canal, a river hazard of long standing has been eliminated. Improvement in the navigation facilities of the Mississippi River has taken another step toward keeping pace with improvements in river transportation itself. Another increment in the development of our national resources has been completed, assuring us a better, safer river.

Britain's Inland Waterways

Review of Past History and Future Plans

In a paper entitled " The Future of Our Inland Waterways " read before the Merseyside Section of the Institute of Transport, Sir Reginald Hill, K.B.E., C.B., chairman of the Docks and Inland Waterways, British Transport Commission, outlined a balanced programme by the Commission for the use of Britain's canal systems. Sir Reginald said: " If you want a strong, healthy plant, you see that its roots are nourished and the good growths encouraged, but you cut out the dead wood. So it should be with the waterways industry—improve and rationalise." He foresaw a good deal of clearing up and gradual sorting out into:

(a) a smaller, but still substantial, mileage of commercially used navigations;

(b) a considerable mileage which, though of little importance for commercial navigation, would be preserved as pleasances or for purposes of drainage or water supply;

(c) a residue no longer required for any of these purposes, the sites of which would be made available for redevelopment.

Applying these general reflections to the inland waterways system, the primary objectives would be:

(i) The realisation that the fundamental purpose of any seller of service is to give satisfaction to his customers by the best and cheapest facilities consistent with financial stability and proper standards of living for the staff.

(ii) Concentration commercially on those traffics which it is physically, geographically and economically best suited to convey. Normally these would include conveyance in bulk between port of entry or shipment and inland destination, or points of origin and consumption, processing or holding, such as waterhead, mine, power station, factory, warehouse or other storage establishment.

(iii) Increasingly intensive use of craft and equipment, by such means as speeding turn-round of craft, full loading and back loading of craft, improvement of shore installations and machinery.

(iv) Research into means of reducing the cost and increasing the efficiency of maintenance of the waterways, dredging and bank protection and design of craft.

(v) Economy of administration and measures to extract the greatest advantage from the property and assets of the waterways.

(vi) A policy of rationalisation that will rid transport users of the cost of maintaining some hundreds of miles of waterways where there are no commercial user or prospects, or where, owing to mining subsidence or other special conditions, maintenance costs are so unavoidably high as to render economic operation impracticable.

(vii) Finally, vigorous and " traffic-minded " management.

The part which the waterways would be able to play in the commercial transport of this country during the next few years would depend largely upon the successful achievement of these objectives.

Sir Reginald's paper was divided into three parts, Part I dealt with the melancholy history of our inland waterways system during the fifty years prior to its passing under the control of the British Transport Commission. Part II considered some of the problems at present facing the Commission in its administration of the canal systems. Part III dealt with the future and hazarded some prophecies.

Years of Decline.

Sir Reginald said when the century opened, the waterways had of course already lost much ground to the railways and their proportion of the total tonnage movements by public inland transport was continually falling; but they still retained an important part, possibly something approaching ten per cent. There were those, concerned primarily perhaps with sustaining a competitor with the railways, who were disturbed at the evident stagnation of the waterways, and in 1906 a Royal Commission was appointed, which made its final report in 1909 after an exhaustive survey. It is interesting to recall the concluding passage of this report, as follows:

> " The Commission have realised more and more, as their inquiry has proceeded, how hopeless it would be to expect anything from the waterway system of England and Wales in the future, for the benefit of trade and industry, if the waterways were left in their present disunited and unimproved condition. With a few notable exceptions, the canals at least would become less and less efficient and useful and many would swell the list, as years went on, of disused or derelict canals."

Accordingly, the principal recommendation of the Commission was the constitution of a central waterway board with statutory powers to acquire and administer such canals as it deemed expedi-

Britain's Inland Waterways— continued

ent. Initially, the Royal Commission proposed the acquisition of the four main routes connecting the Midlands with the estuaries of the Mersey, Humber, Severn and Thames, and it contemplated that these routes should be reconstructed to a uniform capacity to carry barges of at least 100 tons burden. It may be noticed in passing that the conclusion of the need for rationalisation and unity of control was reached several years before the First World War or the amalgamation of the railway companies from 120 different units into four groups, which followed under the Railway Act 1921. Whether anything would have been done to implement the Royal Commission's recommendations had not the cataclysm of 1914 intervened it is now profitless to speculate.

During the years preceding the war of 1914-1918 the tonnage carried by inland waterways of this country was in the region of 40 millions a year. This and other figures, said Sir Reginald, were exclusive of the Manchester Ship Canal. On the outbreak of war the government took control of the railways, including something over 1,000 miles of railway-owned canals. The protective effects of government control were not, however, extended to the independently-owned canals until 1917, by which time the loss of much skilled labour, and the general uncertainty which prevailed in the industry, had resulted in the accumulation of arrears of maintenance and loss of traffic. In fact, the government of the time seem to have regarded waterways as a mere "standby" rather than as a first line of communication and to have been unwilling to face the cost in manpower and money of keeping them in efficient condition. This attitude is underlined by the speed with which the independent canals were returned to their former ownerships and control at the end of the war and left to face unaided their problems of increased wages, loss of manpower and arrears of repair and maintenance. It was said, perhaps with some truth, that, compared with the railways, control of the waterways was belated and decontrol premature.

Public Control Foreshadowed.

The report of the Departmental Committee on Inland Waterways (known as the Chamberlain Report) made in 1921, records the serious deterioration in the position of the industry during the war; a fact witnessed by its tonnage statistics, which in 1924 had fallen to below 16½ million. They too stressed the need to place the more important waterways "under unified and competent management." They were cautious as to the prospects of increased traffic or revenue and regarded the expenditure involved by the Royal Commission's recommendations as prohibitive. They came down in favour of arrangement into seven geographical groups, each owned and administered by a Public Trust whose financial resources should be supplemented by the State and the local authorities. There was to be protection from "unfair competition," at least in the early stages, but the Public Trust should have no monopoly of carriage on its waterways. It should be empowered to purchase land compulsorily for improvements or to secure the benefit of appreciated frontage values. It is, I think, of some interest to recall these views expressed over 30 years ago. Some years later, in 1931, the views of the Chamberlain Committee were generally endorsed by the Royal Commission on Transport, which considered that a good many canals could never again be useful and "ought to be scrapped" but that others "still possess considerable value as a means of transport" and, if properly rationalised and developed, could be made to render much useful service.

Apart, however, from its own difficulties, physical and commercial decline and its lack of rational organisation already mentioned, the waterways industry had to face, during the years between the two world wars, increasing competition from the new, and rapidly developing, road haulage industry. It also encountered periods of severe depression, particularly in those heavy industries with which a great part of its traffic was naturally connected. Apart from one major amalgamation, which formed the Grand Union system, and some spasmodic improvements with governmental financial aid, which were too local and incomplete to enable full benefit to be reaped, little was done to rehabilitate the waterways during this period, and by 1938 tonnage figures had again fallen to below 13 millions.

It will be recalled that just before the outbreak of the Second World War the railways had launched their "Square Deal" campaign and that the Minister of Transport referred their proposals to the Transport Advisory Committee with a stipulation that due regard should be had to the ultimate objective of the co-ordination of all forms of transport. This idea of some sort of "co-ordination" between railways and canals was advocated through a statutory expansion of already existing voluntary joint conferences for co-operation in dealing with competitive traffic. Once more a major international upheaval intervened.

Again the waterways suffered loss of staff at the outbreak of war and again they were at first left uncontrolled. When, following a special report by the late Mr. Frank Pick, they were at last brought under a more or less unified direction and co-ordinated with other forms of transport in the war effort they were generally unable to respond fully to the attempts of the Central Transport Committee to use them to relieve the hard-pressed railways. While allowing for the effects of diversion of shipping to the West Coast upon the waterways serving East Coast ports, it must be confessed that the efforts of the Canal Control Committee, despite the stimulus of the Controller, had disappointing results, as shown by the tonnages carried, which were around 11 million tons a year and sank, as the war ended, to about 10 millions. They were still at about this lowest ever level when, in 1948, they passed direct from government control to the British Transport Commission, which at last provided a permanent unification of organisation, of finance and ownership; they were being worked at a heavy loss, were in poor condition, with heavy arrears of maintenance, and severely depleted resources. It is reasonable to say that only by nationalisation were most of the waterways saved from post-war extinction.

Present Position.

So much for the past. What of the position now that the Transport Commission had acquired the canals. Sir Reginald said that the efforts of the British Transport Commission to rehabilitate the waterways which had passed into their possession had been related in the Commission's annual reports. Reorganisation of management and co-ordination with other parts of nationalised transport, physical restoration by overtaking arrears of dredging, bank protection and craft repairs and new efforts to regain and increase their traffic were the principal means employed, and if they had not been spectacularly successful, as the more optimistic hoped, they had at least arrested the decline and raised the annual tonnage again to over 12 million, while considerably reducing the financial losses. Some of the waterways, notably those in the North East, were earning a reasonable profit although the net result over the entire system was a loss.

In Part II of his paper, Sir Reginald dealt with the position at the present time. The British Transport Commission was responsible for about 2,000 miles of inland waterways including canalised rivers and purely artificial canals, and embracing practically all the commercially navigable water routes except the Manchester Ship Canal, the Bridgwater Navigation, the Thames and the network of watercourses in East Anglia vested in drainage authorities. The Commission also took over approximately one-fifth of the carrying craft operating on its waterways—and here be it observed that, unlike the railways, the bulk of waterborne traffic is conveyed by persons who do not own or maintain the track, but pay tolls for its use.

The nationalised waterways include some that play an active and important part in our transport system and are constantly busy with traffic; however many others whose weed grown and silted waters have long ceased to be used for navigation were also its responsibility. Between these extremes were those used only occasionally or to an extent quite insufficient to support their cost, though some formed important links between busier sections. The concentration of activity was indicated by the fact that about 1,200 miles of waterway account for 98 per cent. of the traffic, leaving only 2 per cent. for the remaining 800 miles. Yet these 800 miles had to be maintained, for you cannot safely leave an artificial water course entirely unattended, and this maintenance costs the Commission on an average between £300 and £400 a mile. In terms

Britain's Inland Waterways—continued

of net receipts some 850 miles of the Commission's waterways earn a profit of about £300,000 a year, while the remainder lose £400,000. Obviously said Sir Reginald the ship was waterlogged! If it was to recover buoyancy it had to be relieved of much of the deadweight it was carrying.

The view is sometimes expressed that if the unused and semi-derelict waterways were dredged and repaired, traffic would return to them and the initial costs, however heavy be recouped. This fails to take into account the fact that industry has not stood still. Apart from competition in transport, some industries have ceased, shifted or changed their needs. In some cases subsidence in mining areas — a continuing threat to the countryside, and to waterways in particular—has been left behind. (This incidentally is a form of destruction to which the public conscience seems strangely indifferent.) So one must face the fact that some hundreds of miles of waterways had to be written off for commercial purposes.

Local Hauls Predominate.

Last year nearly 12½ million tons of merchandise passed over the inland waterways of the British Transport Commission, representing a ton mileage of over 200 millions. If this seems small by comparison with the 22,000 millions of ton miles on British Railways, relative size, capitalisation and ubiquity must be remembered. Coal accounted for about half of the tonnage in both cases, but whereas the average length of haul of coal on the railways was over 56 miles, on the waterways it was not much more than 14 miles. For all traffic, including coal, the average hauls were 73½ miles by rail and 16½ by waterway. This short average haul indicates the predominantly local character of most of the waterborne movements from mines to neighbouring power stations, factories, or to ports for shipment, or from ports to waterside establishments or warehouses. There are still some relatively long hauls between Mersey ports and the Midlands or the West Riding, between London and Birmingham, the Humber and Nottingham, the Bristol Channel and the Midlands, but they constitute only a comparatively small part of the total tonnage, probably only about one-ninth of the coal one-half of the oil and less than one-fifth of other merchandise.

Time is doubtless a factor, though journeys by waterway are not as lengthy a process as generally supposed, but such things as differences of gauge and a multiplicity of interests impede through-journeys. More recently, allocation of fuel output to particular and, where possible, local consumers ; small stocks on hand; difficulties in obtaining crews for journeys involving long absences from home; lack of return loads and consequent long journeys " light," have all played their part.

Waterborne Traffic.

The principal commodities, other than coal, now conveyed by waterways are, in order of tonnage, petroleum, grain and flour, timber, chemicals and iron and steel. It will be noticed that these are all mainly imported in bulk and that their inland voyage is very largely a prolongation from seagoing ships, at a seaboard port, to an inland port or waterhead for distribution. In this respect they serve, by transhipment to smaller craft, the purpose of the Manchester Ship Canal to bring overseas imports as near as possible to the markets. Leeds, Worcester and Nottingham are examples of such waterheads, which are an increasingly important feature of waterway transport, and their possession of transit shed and warehouse accommodation, properly equipped and served for distribution or onward movement, is normally and essential feature of their development. Thus they can provide, in combination with road transport, a convenient and economical service. There should also be possibilities of combination with coastal shipping to facilitate the penetration of coastwise traffic to inland points and thus minimise the handicap of relative inaccessibility under which the coaster so often labours.

Three years ago the British Transport Commission issued statements in which they indicated broadly the kinds of traffic for which they believed that road, rail and water transport are respectively most suitable and efficient. For water transport, they mentioned " traffic imported, and for shipment in the ports connected with the inland waterways, particularly where overside exchange between ship and barge occurs and trunk haul to river or canal waterheads with subsequent delivery by road." This indicates one of the principal existing and potential uses of the waterways. If, by overside transhipment, port charges are saved, the operation may present substantial savings in forwarding costs. For purely inland movement, the cost of transhipment may be heavy and, except where traffic is going into store, it seems likely that the waterways must increasingly rely upon point to point conveyance, without break of bulk, between establishments on their banks.

Rationalisation Policy Needed.

The foregoing considerations, said Sir Reginald have largely determined the policy of administration under the Commission. They indicate that available resources should be concentrated on routes and traffics where there are fair prospects because they are able, or can be adapted, to provide a service which is wanted—*where* it is wanted. Such a service must be competitive in cost, convenience and reliability, and in endeavouring to provide it, regard must be paid all the time to the inherent limitations as well as to the advantages of our waterways system. For example, one advantage of water transport is its comparatively high unit load capacity. But the superior carrying capacity of a barge, compared with a lorry, may largely be lost if the lorry can perform several journeys while the barge is making one. Now, apart from the Gloucester and Berkeley Ship Canal and the Caledonian Canal, the carrying capacity of the craft that can navigate the Commission's waterways, ranges from the 25 tons of the narrow boat (or 50 tons if it hauls a butty) to about 400 tons of the largest barges on the Weaver and the Severn. On the Trent, a tow of barges with combined capacity of 500 tons can be passed in one lockage and the compartment boat system of the Aire and Calder can transport up to 700 tons in one movement. These capacities could only be increased substantially at very heavy cost by enlarging the locks, and in most cases, the navigation channels themselves.

Nonetheless something had been done by ensuring depths to enable existing craft to be loaded to full capacity, by straightening bends, dredging and enlarging bottlenecks. At the Commission's newly-opened hydraulic research station near London experiments were being carried out to find if, by improved design or new methods of construction, speeds could be increased without endangering banks by erosion through wash or wave formation and if greater pay load capacity could be achieved within the dimensions physically imposed upon us.

On the operational side there was clearly scope for improving the turn-round times and reducing idle time of craft and thus obtaining better use of their capacity. In a small way, greater pay load capacity has been achieved in three craft recently added to the Leeds and Liverpool fleet. Constructed of high tensile steel, which gives lower tare weight than mild steel, they are capable of carrying ten per cent. more cargo than older craft of similar size. There may be further developments in this direction. Another interesting innovation which promises speedier and more economical operation where conditions are suitable is the use of light tractors to tow barges from the towing path.

The cost of maintaining the water tracks with their structures, plant and equipment, looms largely over their budgets. On the average of the last three years (1950-1952) it amounted to £1.4 million a year and accounted for two-thirds of the total annual expenditure on the Commission's waterways. This is a heavy burden in relation to some 12 million tons of traffic and gross receipts from all sources of £2 million. Obviously it must be closely and anxiously watched and full advantage taken of any means of cheapening cost without loss of efficiency. Dredging and bank protection, the joint heritage of age and mechanisation, are the chief items and better and cheaper methods of effecting these are being sought with the aid of research and experiment. We could not afford not to progress in these respects.

The Commission carry only a minor part of the traffic using their waterways; by far the greater proportion is conveyed either by independent carriers or by traders who carry their traffic in their own craft. Thus the nationalised canals do not carry any of the in-

Britain's Inland Waterways—continued

creasingly important and growing petroleum traffic and only about eleven per cent. of the waterborne coal tonnage. Relations with the carriers and bye-traders have from the first been amicable and co-operative and so far there has been no need to use the special powers conferred by Section 35 of the Transport Act of 1947. It follows that a substantial responsibility for the adequacy and efficiency of transport on the waterways rests with the carriers and that much must depend upon their enterprise and ability to develop their businesses. It is up to them to play their part and to justify the expenditure involved in maintaining and improving the tracks on which they ply.

Sir Reginald also referred to the use of canals for tourist purposes. Some waterways offered a new form of holiday and a chance to see the countryside from a new angle providing a restful contrast to the hustle and bustle of everyday life. It might be hoped that the most attractive parts of waterways no longer needed for commercial navigation will be preserved as amenities in the national interest.

Future Outlook.

In the third part of his paper Sir Reginald referred to future plans. He said: " All sound planning must rest upon some sort of projection of the past as well as foresight of likely needs and developments of the future; but the student of our inland waterways has to beware of facile, but contending arguments. On the one hand are those who dismiss the canals and inland waterways as a mode of transport that has no doubt served us well, but has had its day, is now outmoded and should be extinguished, or at least allowed to pass peacefully away. These argue that the size and physical conditions of Great Britain are not favourable to economic transport by water. Let us have roads—and more roads, they say. On the other hand are the believers in the supreme virtues of movement by water, who point to the great canals and waterways of Europe and America and argue that great expenditure here on restoring and enlarging our own navigations would be a sound national investment. Our waterways system has, they say, been starved and neglected and has not been given a fair chance of proving its potential value. Back to the Canals!"

He said there were of course, elements of truth in both these extreme views. We did not possess great river systems such as the Mississippi-Missouri (with a navigable length of 2,700 miles) or even the Rhine, capable of carrying large cargo units over great distances. The 1,000 and 2,000 ton barges common on the Continental waterways could not travel on our inland waterways, still less, of course, the 10,000 ton units of America. At the same time we had the most intensive rail and road systems in the world. Comparatively little has been done in this country since the original construction of the canals, to develop or modernise them —nothing, for instance, in any way comparable with the Albert Canal in Belgium—the Manchester Ship Canal excepted. On the contrary, they have been left until recently in the hands of those who lacked the resources or incentive for major improvement, and generally for adequate maintenance.

He did not accept the conclusions either of those who would abolish our inland waterways system or of those who regard it as having unlimited potentialities. Like most other human activities, transport seems to him to be becoming increasingly a matter of specialisation, where each mode will find its place according to its particular aptitudes and its capacity to fit into a system suited to the needs of the community it serves. Whatever may be the early effects of the Transport Act passed this year, he did not believe that transport could ultimately be divided into mutually insulated departments. Whatever its ownership, each form of transport would come to be viewed, and used, in relation to the whole system.

Looking Forward.

What then of the future?

Long term prophecy in this field could be little more than imaginative guesswork. In our own lifetime, changes in practical methods of mobility have followed each other with bewildering rapidity and means undreamed-of. Who then could pretend to say how freight would move twenty or thirty years hence? There may well be fundamental changes in the functions of transport, in its relative importance and in the volume of tonnage requiring movement, especially over long distances. Even transport tracks, whether rail, road or water, may be put to different uses. Apart from movement by air, there may be revolutionary developments of pipe-lines, moving platforms, chain conveyors, to mention only a few of the possibilities of the future. Under this growing shadow of obsolescence we can plan only for the comparatively near future. This incidentally seems to imply a warning as to the rates at which capital works and equipment should be depreciated and capital expenditure written off. We may have drastically to revise our ideas of the useful " lives " of transport assets, and to adopt lighter and cheaper, but less durable, structures and machines. A structure built to stand and function for 50 years is likely to be an uneconomic investment if it is obsolete or unwanted in ten! Wasteful effort and expenditure must progressively be eliminated and there must be concentration on those services or facilities which could be provided most effectively with a corresponding scrapping of those which are less efficient. Sir Reginald then outlined the programme of rationalisation set out at the beginning of this article.

International Maritime Exhibition

Meeting at Naples, May—October, 1954

The third annual reopening of Naples Fair, the Mostra d'Oltremare e del Lavoro Italiano nel Mondo, will be marked, in May 1954, by the International Shipping Exhibition to which numerous countries and international organisations are giving their support and collaboration.

Situated in the Phlegrean Fields, at the foot of the Posilipo Hills, the grounds cover an area of one million square metres and also include a special building for congresses and conventions, an open-air theatre with a seating capacity of twelve thousand and a ten-storey building reserved for the United Nations.

Patronized by the Italian Government, the forthcoming Shipping Exhibition will be supported by those countries and shipping companies interested in the development of commercial contacts throughout the world.

The organisers of the Exhibition have endeavoured to keep it away from any arid documentation and complicated statistical data, but intend to give a comprehensive illustration of every activity which is connected with the shipping industry.

The Exhibition is designed to show the developments of navigation, shipbuildings, ports and the industries related to shipping, and their further possibilities of progress. It is divided into 9 sections, including:

Section 1. The Economic Organisation of Navigation.

(a) Tramp shipping, freight market and its organisation
(b) Passenger lines—Steamship Companies
(c) Steamship agencies
(d) Ship chandlers and bunkerage
(e) Marine insurances
(f) Special trades: Refrigerated vessels, Oil tankers, Bulk carriers, etc.
(g) Inland navigation and main waterways

Section 2. The Technical Organisation of Navigation.

(a) Hydrography
(b) Lighthouses and Light buoys
(c) Navigation aids : wireless, radio telephone, radar
(d) Ships Salvage and Life saving at sea
(e) Pilotage
(f) The Health Maritime Organisation

Section 3. The Port Organisation.

(a) Harbours and Port Works
(b) Port Authorities and the Hinterlands of principal commercial ports of the world
(c) Port facilities : Dry and floating docks, Silos, Coldstorage, Warehouses, Mechanical equipments (elevators, conveyors, cranes, etc.)

The New Trinity House

Restoration of the Original Wyatt Building

On October 21st last, H.M. the Queen, accompanied by H.R.H. the Duke of Edinburgh, who is an honorary Elder Brother, visited Trinity House, when Her Majesty formally opened the restored Wyatt Building and the new modern office extension recently completed under the direction of Professor A. E. Richardson, R.A. The original group of buildings comprising " Trinity House " were blitzed in 1940 but the main building, of late 18th Century Classic style has been restored as far as practicable to retain the original fixtures.

The royal party was received first by the Lord Mayor of London and the Mayor of Stepney and then by the Duke of Gloucester, the Master of Trinity House. The Duke of Gloucester said that the occasion was one which they of the Trinity House had looked forward to with great expectation for the past 13 years. The Queen's presence set a seal on their long history. Since their incorporation by Henry VIII, Trinity House had been situated at Deptford, Ratcliff and Stepney, and finally in the vicinity of Tower Hill. It had been destroyed by fire three times; first in the Great Fire of London in 1666, again in 1715, and finally in the air raid in 1940. The walls of the building that remained had been restored and incorporated in their new home, which was a replica of what it was in 1795. Under whatever roof The Trinity House was situated its work continued, and that work, in all its many branches, was one of service to the mariner. To mark the memorable occasion, the Duke added, they asked the Queen to accept a ship's bell far the Royal yacht *Britannia*. It had been cast in the Royal Dockyard at Portsmouth.

" Trinity House " or " The Corporation of Trinity House " to give its formal title, stood on part of an island site and consisted of a stone-faced main building designed by Samuel Wyatt in 1793, and an adjoining brick building erected some years later was designed by the same architect with the possible assistance of his brother James Wyatt. Behind these, were several old Queen Anne houses used as offices to house the headquarters staff; although in recent years the staff had overflowed into adjacent buildings. Behind the old houses was a mid-Victorian block which housed a library hall and a large room used for lighthouse illumination experiments. Also on the island site with the Trinity House buildings was a large warehouse. The complete destruction of the latter in 1940 enabled the Brotherhood to purchase its freehold and thus acquire the freehold of the entire site. Plans could thus be put into operation for a new Trinity House with modern office buildings capable of housing the entire headquarters staff on present day lines, thus meeting a long-felt need.

Professor A. E. Richardson, R.A. was called in to advise the Corporation as to the best method of adapting the site. He therefore prepared a design, which while preserving Samuel Wyatt's original building—a scheduled one under the Ancient Monuments Commission — provided for the construction of modern office accommodation sufficient for all departments of the Corporation's staff, and for a new wing incorporating library hall and corporate offices.

The Ceremonial Rooms.

In the original Wyatt building he has restored as far as possible the former ceremonial rooms including the main stairway which had been an attractive feature of the house, and the landing on the first floor which had always been known as the Quarterdeck. The semi-dome above the stairway has been retained, also the side galleries overlooking the Quarterdeck.

The Court Room, the Reading Room and Master's Room have been completely restored and such portraits as have survived have been put back in their former positions. Although the whole building is now centrally heated, the marble fireplaces of the principal rooms have been replaced either by contemporary ones or replicas of the original.

The lighting of the whole building, as formerly, is by electricity. A vast chandelier of mid-Victorian design, and never intended by the original architect for the Court Room, has been retained and the lighting is from reflected light concealed in the coves. The courtyard railing with its late 18th century lamp standards have been restored, as a feature of the original building, and the opportunity has been taken of providing floodlights along the curb of the railing.

The entrance hall of the Wyatt building which formerly contained so many of the Corporation's ship models will still be used for such purposes, but the heavy mahogany cases, added during the Victorian era, which had spoiled the proportions of the room, have not been replaced; the committee rooms on each side of the hall have been restored as originally. The principal stairway with its beautiful wrought iron balustrading was completely destroyed and has been replaced exactly as before the fire. The semi-dome above the principal stairs and the adjoining wall originally contained Grisaille work by Rigaud—they have not yet been repainted.

The new east wing, which now contains the library, is reached on the first floor by the extension of the original quarterdeck, where also a luncheon room has been provided. The library runs the whole length of the original east wing which was demolished. It contains a gallery, and around the walls are built-in bookcases to house the Corporation's library. Three windows facing east have been filled in with stained glass. The centre one containing the Corporation's Arms is modern, having been designed by Mr. Francis Spear, who has also rearranged in the two side windows the original medallions containing the Arms and Merchant Marks of former Elder Brethren of the 16th, 17th and 18th Century, which fortunately had been removed to safety during the war.

Above the south window in the Library is a plaque containing the Arms of Henry VIII who granted the first Charter of Incorporation to the Trinity House in 1514, and the Duke of Gloucester, the present Master, on either side of those of the Corporation's Arms. The east wing is surmounted by a very handsome weather vane in the form of a gilded ship of the 16th century. Above the Library is a flat for a resident housekeeper, while below on the ground floor are the Corporate offices, and in the basement the kitchens and other domestic offices have been provided.

The office block situated along Savage Gardens and Pepys Street is in keeping with the rest of the building. It consists of six stories and basement and has every modern convenience. There is an entrance in both Savage Gardens and Pepys Street and that portion of the block facing Pepys Street has been called Colchester House, to perpetuate the former name of that part of the street, which was named after the Earl of Colchester, who at one time owned the property.

The Royal Charter of Henry VIII.

It is not generally realized that Henry the Eighth, although of infamous reputation in some respects, nevertheless was a brilliant statesman and took a great interest in seamen and the Royal Navy. Trinity House, in its present form, owes its inception to Henry's Royal patronage. A Mariners' and Pilots' Guild with a hall and almshouses at Deptford was already in existence and Henry incorporated them by Royal Charter in 1514 as " The Master, Wardens and Assistants of the Guild, Fraternity or Brotherhood of the Most Glorious and Undivided Trinity and of Saint Clements." As such they remain in their full title to-day. This noble phrase was too much for general use, however, even in those supposedly leisurely days and from the very beginning was abbreviated to " The Corporation of Trinity House " or just " Trinity House." The celestial patrons invoked in their title were, of course, the Holy Trinity and St. Clement, the patron saint of sailors.

The Charter granted them the privilege of " . . . considering matters concerning the science and art of mariners with power to make ordinances for the relief and augmentation of shipping and to hold land for religious and charitable purposes." They were directed to elect one Master, four Wardens and eight Asssistants each year to direct their activities. They were to be known as Brethren and—very strangely—women were to be admitted as Sisters. This cordial pre-vision of women in the maritime services however seems to have led nowhere, for Sisters are never again mentioned although the Brethren flourished.

The first Master of the Guild was Sir Thomas Spert, captain of the *Henri Grace a Dieu*, the principal ship of Henry's navy, and later Masters have included General Monk, Samuel Pepys, the Duke of Wellington, the Prince Consort and other members of the

The Editor is indebted to The Decca Navigator Company Ltd. for permission to reproduce material published in their house journal.

New Trinity House—continued

British Royal Houses. King George V was Master before he ascended the throne and King George VI was an Honorary Elder Brother; the present Master is H.R.H. The Duke of Gloucester. H.R.H. The Duke of Edinburgh and Sir Winston Churchill are Honorary Elder Brothers.

The number of ruling Brethren is fixed by charter and has been changed from time to time through the centuries. At present they are twenty-three. Ten of them are active, working at Trinity House as a Board of Directors might, under their Deputy Master Captain Gerald Curteis, M.V.O, R.N. (retd.) ; the others are honorary, but attend special Courts of the Corporation. All have distinguished careers behind them in public life or at sea, and as already indicated, the highest in the land have considered it an honour to be an Elder Brother of the Guild. There are of course Younger Brethren, membership in this category being open to those either of the Royal Navy or Merchant Navy who have commanded ships at sea. Their numbers have no statutory limit and it is from their ranks that vacancies among the ten " working " Elder Brothers are filled by election.

As might be expected, a large administrative and technical staff is employed on the practical work of Trinity House. To-day this includes the examination and licensing of pilots, building and maintaining lightships and lighthouses, the placing and supervision of buoys, seamarks and landmarks, and investigation into new methods of marine navigation and safety at sea. In this last connection the development of electrical devices in recent years has led to the formation of a new department under a Director of Electrical and Electronic Services, supplementing the two older divisions of the Engineer in Chief and the Surveyor of Shipping and Marine Engineer.

Administrative Districts.

For the purpose of administering the lighthouses and other services, the coast of England and Wales was divided into six districts. They are named after their depot towns : Yarmouth, Harwich, Cowes, Penzance, Swansea and Holyhead. Maintenance staffs, stores and workshops are stationed at each, as well as the lighthouse tenders which go out on the actual day-to-day jobs of inspection, repair and crew relief. There are nine steam tenders in the lighthouse fleet, one at each depot except Harwich, where there are four. They vary from 500 to 2,000 tons gross and are fitted with powerful handling and lifting gear besides all kinds of position-finding devices including the Decca Navigator.

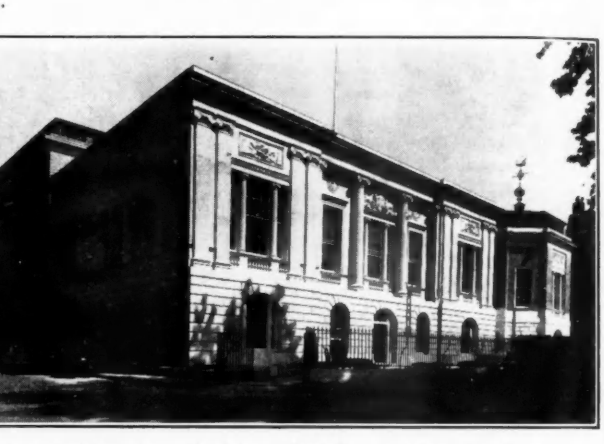
All told, Trinity House have some 40 manned lightships to maintain (a few are not fully back in commission since the war) and 97 lighthouses. Forty of the latter are classified as minor lights, having no full-time attendants, two are fog-signal stations only. Life on the lightships is probably the most arduous, but on the rock lighthouses it is most trying.

Lighthouses, for some reason, seem to fascinate the landsman more than lightships although they are stable and, by reason of their traditionally magnificent design and construction (again thanks to Trinity House) quite safe. The fact that a keeper can be bound fast to his island home for weeks at a time by stormy seas brings a thrill to newspaper readers that no trouble on a lightship ever quite matches, and all Britain was on tenterhooks on the memorable occasion some years ago when a pair of B.B.C. commentators found themselves prisoners on the Bishop Rock Light for two months after a Christmas broadcast.

Yet lighthouses are founded upon the rock while lightships have nothing to hold them but the rolling sea itself. Their hull is a shell like any other ship's and as liable to founder. Every storm must be faced and ridden out, they may not run for shelter—indeed they cannot run for shelter for they have no propulsive machinery. Their reliefs too may be delayed, though not to such an extent as at isolated lighthouses surrounded by dangerous rocks.

The first warning lights were merely fires in a brazier. Later came candles and paraffin lamps. For a long time they were planned and run by private enterprise, profit accruing to those who built them from shipmasters who would rather pay a levy than run aground. Pepys himself was tempted, in his younger days, to concern himself with a light or " sea-marke " proposed by a Captain Murford who assured him he would make £100 per annum by it, and it was not until 1836 that Trinity House finally became responsible and the entrepreneurs were bought out. To-day the illuminant of the most modern lights is generally electricity or dissolved acetylene. One charge of acetylene will keep some buoys burning for a year. The flashing on buoys is nearly always arranged by the gas pressure operating a valve, and not everyone even at sea, observes that they flash by day as well as by night.

Buoy maintenance is largely routine and uneventful. They are frequently visited and inspected, changed when damaged by accident or collision, and in any case changed every twelve months, the old one being taken back by the tender for overhaul at the depot. The Decca Navigator has proved useful in this respect as it enables an easy check on positioning to be made by the official vessels. Other shipping who are fitted with this apparatus also advise Trinity House if the Decca co-ordinates suggest that a buoy has been dragged by even a small amount. The number of buoys maintained by Trinity House is about 600, 150 of which are lighted. They also maintain 47 unlighted beacons or landmarks round the coast.



The new Trinity House building will bring together all the departments of the Corporation which were previously housed separately. Trinity House has a triple function as lighthouse authority, pilotage authority and administrator of corporate charities and estates.

Other Responsibilities.

Less widely known perhaps, is that Trinity House is responsible for wreck removal. They are not equipped for large scale dispersal work, which is contracted out to private salvage firms or the Admiralty Salvage Department, but the onus of keeping all home fairways clear of wreckage remains upon them. Another heavy responsibility of the Elder Brethren is their duty of acting as Assessors in the High Courts, particularly the Court of Admiralty.

As to Pilots, Trinity House does not employ them, but it licenses them and has to see that the supply meets the demand. There are at present about six hundred on their roll, most of them working Southampton Water, the North Sea, and the Thames, over which the Brethren are the responsible Pilotage Authority from London Bridge to the Sunk Sand and Dungeness. Although the members of the Guild no longer act as pilots themselves, they jealously guard one great privilege—that of preceding the Sovereign when going to sea or on ceremonial naval occasions. It was the Trinity House Yacht *Patricia* with the Elder Brethren aboard which led H.M.S. *Surprise* through the fleet at the Spithead Coronation Review.

Finally, Trinity House remembers that it was founded in charity; that it had almshouses at " Deptford Strond " over four hundred years ago, and that the care of old and destitute seafaring men as well as the education of young dependents, are causes which, in these islands, can never be forgotten. Its practical work in making home waters safe for mariners is, properly, paid for by shipping interests by means of light dues." Its humanitarian work rests in the goodwill of its founders and to the spirit of charity still alive among lovers of the sea to-day. Thanks to them it flourishes, and rare indeed are those among the aged, the widowed or the orphaned who look in vain to the Brotherhood of the Trinity for help.

Dredging at the Port of Melbourne

A Review of Recent Developments*

An intricate assignment, undertaken on an average of only about once every five years, was carried out at Melbourne Harbour recently when those sections of the River Yarra, where obstructions are located close to the river bed, were dredged to the maximum possible depths.

The work entailed continuous supervision by a skilled survey party, for any error of judgment during dredging could have resulted in damage to costly installations, with grave impairment of utility services—sewer tunnels, oil pipe lines, and electric cables.

When these installations were first set in place the depths at which they were located appeared to be ample for future shipping requirements in the river. But state, port and technical progress were more rapid than ever conceived by our predecessors, calling ultimately for widening and deepening of the river in order that it might readily be navigated by the larger ships visiting the port.

The deepening of the river has had the effect of bringing installations under the river closer to the surface—so close that dredging in the areas must now be undertaken with extreme care.

Plans have already been approved for the re-building of the principal obstruction, a sewer tunnel at Spotswood, at a considerably greater depth than at present. Not only must a modern port have elbow room on its wharves and approaches, but its channels must be capacious, and the development scheme of the Melbourne Harbour Trust Commissioners provides for an extensive widening and deepening of present port waterways.

Obstructions.

The sewer tunnel obstructions met in the recent dredging project were at Johnson Street and Spotswood. The former comprises a concrete tunnel 2-ft. thick and 3-ft. 3-in. in diameter. The top of this tunnel is 29-ft. 8-in. below low water and dredging was carried out to within 2-ft. 8-in. of that point to 27-ft.

The second tunnel, at Spotswood, is much larger, being 9-ft. in diameter and built of cast iron rings lined with concrete. The top of this structure is 34-ft. 10-in. below low water and dredging was carried out to 31-ft. 6-in., leaving 3-ft. 4-in. of stiff protective clay. Dredging to 44-ft. will be possible when this tunnel is replaced by two smaller tunnels.

Further downstream electric cables cross the river, lying in a trench excavated over 30 years ago. Dredging, under surveyors' supervision, was carried out to within 27-in., but for safety, the 22,000 voltage power was turned off during the operation.

Oil pipe lines comprised another hazard, the dredge buckets cutting to within 15-in. of them without mishap.

Under such conditions dredging, always a science, becomes something of an art—an art at which the technicians of some of the world's greatest ports excel.

River Ports.

Many principal ports are located on rivers: London, Liverpool, Glasgow, Newcastle, Hamburg, New York and Antwerp among them. In all, as in the Port of Melbourne, there is inevitable siltation, calling for dredging.

The theory of the ideal port calls for natural deep water, adequate shelter for ships, and ample space for activity. In practice, few ports can measure up to the theory. The pattern of history is that people form a township on a site not because of its potential port suitability, but because of its strategic location to pasture land, raw materials—and fresh water. Under such circumstances have the river ports come into being, constructed to serve the already existent community. Such was Melbourne's genesis, with the port literally carved from virgin soils in the delta of the Yarra to meet the requirements of the people.

From the earliest days of the port, dredging has played a significant role in the maintenance and development of facilities, and in that period about 50 million cubic yards of solid material have been dredged: sufficient to cover the square mile of the city of Melbourne proper to a depth of almost 50-ft. The official seal of the Melbourne Harbour Trust, designed three-quarters of a century ago, bears a dredger in its insignia.

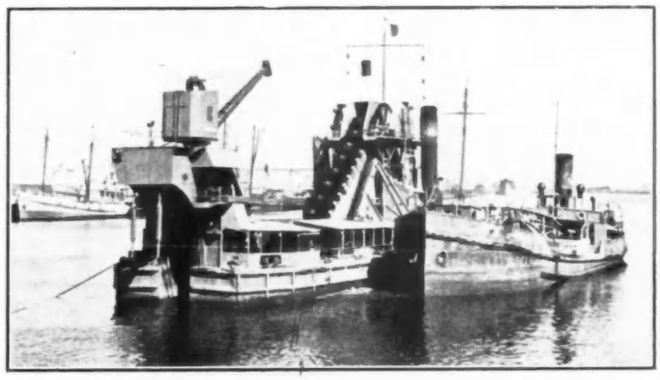
Maintenance Dredging.

Dredging is unspectacular work, with its achievements mostly out of sight, beneath the port waters. The massive holes excavated during dredging (recent work on the River Entrance Docks site alone meant the removal of 4 million cubic yards of material) would attract crowds of sightseeres if effected in solid land, but being unseen excite no comment.

But even if unspectacular its achievements are remarkable, and, although lacking the drama of the tons of rock cascading high into the air, typical of dam and similar construction, nevertheless produces marked physical changes in the environment.

This " tailoring to measure " of the port has meant that costs to the community have been kept to a minimum and the overall savings have been incalculable. It has not been necessary to mould trade and shipping requirements to port limitations—the port has been developed to match the needs of commerce.

Every channel in the Port of Melbourne has a guaranteed depth, listed on the Admiralty Charts, and also recorded in the annual Port Information and Tide Tables booklet issued by the Trust. These depths must be maintained, but the system employed is not one of a shallow scraping of the waterways at short intervals, but of dredging a " compartment " down to a depth of 4-ft. greater than the depth guaranteed—with perhaps no further dredging on the site for another eight to ten years. This is not possible in the " obstructed " sections which must be dredged more frequently.



The bucket dredger *A. D. Mackenzie* which recently came into service at the Port of Melbourne.

Over the years silt accretes in the compartments, and when the level guaranteed is being approached, dredging is carried out. Hydrographic survey is carried out continuously in the port, with special sonic gear which " graphs " the river bed, and enables the dredging programme to be drawn up and modified.

The silt is excavated by bucket dredgers and deposited direct into hopper barges for transport to a deep water area some nine miles south of the Gellibrand Light, where it is dumped.

The scientific technique of maintenance dredging is matched by the technique of costing and for the weekly meeting of the Board of Commissioners the average cost of each yard of material dredged is available. The cost is not only brought down to pence per yard, but to two decimals of pence. The amount varies from week to week and bears a direct relationship to a number of factors—weather conditions, traffic necessitating continual suspension of work, local difficulties, and others, all of which are listed and dissected to the finest possible point.

Similarly, the frequency and the extent of dredging depend on capricious factors beyond the control of the Port Authority. Bush fires in the hills, for example, mean the need for a much greater maintenance dredging in the port. The fires burn off the protective green covering on the hillsides. Rains then wash the topsoil into the streams which feed the River Yarra and the Maribyrnong River. The heavy material is deposited upstream, but the mud is brought down to the port area where the wider and deeper channels cause a decrease in the rate of flow of the waters, and the material carried in suspension sinks to the river bed, whence it must ultimately be dredged up as silt. The Yarra at Queen's Bridge can move along

*Reprinted from the Port Gazette of the Melbourne Harbour Trust, October 1953.

Dredging at the Port of Melbourne—continued

many times as much mud in suspension as it is capable of doing below Spencer Street Bridge.

Construction Dredging.

It is maintenance dredging which keeps the port open, but the actual building of the port has leaned heavily on construction dredging, throughout the history of the Port of Melbourne.

The original port site comprised a relatively narrow and shallow river, meandering through a muddy river delta to a shallow bay. The keynote of port development was excavation and reclamation to provide the present 106 berths along a frontage of twelve miles.

Excavated mud is suitable only for dumping, but sand and clay brought up from the river bed have been used extensively in reclamation projects. What to-day is dockland was once swampland, reclaimed by the Trust.

At Appleton Dock, of which the first stage of five berths is steadily approaching completion, the cutter suction dredger " G.F.H." was employed in recent years to pump 650,000 cubic yards of solid material into reclamation ponds to provide foundations for roads, railways, sheds and other buildings. The area reclaimed totalled 67 acres.

The emphasis of Trust dredging activities is on construction dredging under the port's development projects, and last year more than two million cubic yards of material were raised in construction works at Appleton Dock, River Entrance Docks, in the River Yarra and at the Williamstown Piers, compared with 325,000 cubic yards in maintenance dredging.

The dredging ensures that any vessel which can navigate the Heads leading into Port Phillip Bay can be berthed in the Port of Melbourne.

Dredging Plant.

The core of the dredging plant comprises five bucket dredgers, including the side ladder bucket dredger " Latrobe," built specially for the Trust, and the only one of its type in the Southern Hemisphere.

The last acquisition to the dredger fleet was the bucket dredger " A. D. Mackenzie," which arrived in the port early in 1952, having been built to the Trust's specifications by Lobnitz & Co., Renfrew. Under service conditions this fine dredger has proved capable of removing 1,000 tons of material per hour, and has been used extensively on construction work.

The cutter suction dredger " G.F.H." was in service at Appleton Dock, dredging some 30,000 cubic yards of spoil weekly, and is now undergoing refit before being brought into service on the River Entrance Docks site.

The " G.F.H." is a powerful unit capable of dredging to a depth of 70-ft. below water level and of bringing up 1,000 yards of material an hour, placing it through 40-in. diameter pipes to reclamation ponds a mile distant.

Operating in conjunction with the dredgers the Trust employs seven steam hopper barges and four dump hopper barges, as well as four tugs. A large modern steam hopper barge was lost last year on its delivery voyage to Melbourne, and a replacement is under construction at present. It will prove a valuable addition to the present plant.

Future Dredging.

Although an immense amount of dredging has been carried out in the past, considerable work remains to be done under the development and expansion projects of the port, designed to provide facilities adequate for trade and shipping demands.

The trend towards the construction of larger vessels of deeper draft is being met by port development and the dredging programme continues to ensure that every vessel entering the port shall be able to move direct to a berth.

Permanent International Association of Navigation Congresses

The XVIIIth Congress held at Rome in September, 1953

Impressions of British Observers

The Permanent International Association of Navigation Congresses which held their eighteenth meeting at Rome in September last was attended by delegates from 35 countries. The subjects under review in the two sections, Inland Navigation and Ocean Navigation, covered a wide field. Many valuable exchanges of ideas and experiences were made following upon the Questions and Communications presented.

Inland Navigation matters included:

1. Waterways (streams, rivers, and canals) subject to heavy floods and large variations of water level.
2. The location, orientation and dimensions of inland ports.
3. The distribution of the sediment carried by a waterway which branches, either naturally or artificially.
4. The cross-section, the method of revetment, the distribution of velocities in a waterway, and the permissible speeds of vessels.
5. The methods of signalling for navigable inland waterways.
6. The capacity and dimensions of locks, and the inclusion of lay-bys.

Maritime Navigation matters included:

1. New designs of breakwaters with vertical sides and of structures with sloping faces.
2. The impact produced by ships when berthing alongside more or less heavily; forces produced by wind and by currents; the result of the impact on the fenders, etc., and on the mooring appliances both of the ships and of the structures; the means of minimising the effects.
3. Measures against corrosion and deterioration of various construction materials with special reference to the lower parts of wharves, quays, etc., in deep water.
4. The latest developments in waterside areas in ports and their equipment (especially the area available on each side of sheds, etc.). In the handling of various types of cargoes, excluding bulk cargoes, from the holds of the ship to the final means of transport (i.e. by rail, road or barge). In the storage of goods. For the surfacing of waterside areas. Special arrangements for cold storage. Comparison between the lifting appliances on board the vessels and on shore. Passenger facilities.
5. The penetration of salt water in tidal rivers and their tributaries, in maritime canals, and in ports.
6. The trend of recent developments in dredging craft and in their use.
7. Pollution in harbours.

It is possible that this Journal may be able to publish in future issues some of the papers dealing with the wide range of subjects outlined above. Meanwhile, the comments given have reference to Section II of the Congress—Ocean Navigation.

Question I of Section II produced a lively discussion dealing almost exclusively with wave action at breakwaters. Mr. R. Iribarren (Spain) made an outstanding contribution as did Mr. J. Larras (France). The only other aspects of the question touched upon were by Mr. E. W. Bijker (Holland) of Delft University, who gave a new formula for the height attained by waves on sea walls and by Mr. C. H. Dobbie (Great Britain) who called attention to the plastic elastic behaviour of bitumen grouted structures.

So great was the interest aroused on wave action that it was decided to appoint a drafting committee to rewrite the conclusions in the General Report. The committee consisted of M. A. De Rouville (France), Dr. Ing. Guido Ferro (Italy) and the authors of the papers. After a series of meetings, the draft was eventually agreed and read to the final assembly by M. De Rouville.

Professor A. L. L. Baker (Great Britain) of the City Guilds College, London, contributed a paper on " The Control of Impact on Marine Structures (Section II, Question 2) in the introduction to which he said that " The heavy and solid type of wharf or jetty built at great cost, and the braced steel pile pier, have now been almost entirely superseded by light reinforced concrete or unbraced steel box pile structures, protected by shock absorbing fendering. The design of fendering has therefore become very important, since without highly resilient protection the main structure would be un-

Permanent International Association of Navigation Congresses—continued

able to withstand the forces of impact, and costly damage would frequently occur both to wharf and the ships." Dealing with structural requirements to meet these conditions, Professor Baker went on to say that " sufficient records are not yet available to establish from a statistical analysis appropriate collision speeds for various conditions " and stated that " records based on the measured compression of the springs or movement of gravity fenders should be more relied upon than observation of speed." A table compiled by Professor Baker shows that for a given maximum impact of, say, 100 tons required in order to safeguard a light jetty structure or avoid damage to shipping, gravity fenders can provide about twice as much shock absorption as time or buffer springs and about 10 times as much as a single layer of 12-in. rubber tubing.

In the course of the discussion it was pointed out that the construction of larger ships with weaker hulls, the need for quicker turn-round, the use of berths on exposed sites and the use of fairly rigid reinforced concrete construction make the increasing use of shock absorbing devices imperative.

Attempts to use complex mathematical formulae to calculate the velocity in berthing were criticised by one speaker, since it was felt that the skill of the shipmaster, the pilot and the tugmaster entered into the problem which was really a statistical one. A safe limiting value of velocity could only be arrived at from observations of a number of berthings under various conditions.

The agreed conclusions on this section were that shock absorbing devices were becoming increasingly necessary, that the rubber sausage type was suitable for solid wharves which were not exposed, and that mechanical high shock absorbing fenders were necessary in conjunction with open construction. To evade longitudinal blows or provide longitudinal resilience was an important requirement for such fenders. Insufficient is known about the strength of ships' hulls, and more information should be sought from naval architects and ship research organisations.

Mr. C. J. Buckley (Eire), Principal Assistant Engineer, Dublin Port and Dock Board, contributed to the discussion on fenders and made the following points:

1. Open type jetties, being to some extent flexible, need shock absorbing fenders to protect them from heavy berthing loads.
2. These fenders will do their job well provided that the ships come alongside in the way they should.
3. If, for one of many possible reasons, the angle of incidence of approach of a ship to such a jetty is great,
   (a) the ship's stem may strike a fendering unit on its edge, as it must project in front of the normal jetty face,
   (b) the ship may strike the jetty between fenders and damage the decking, etc., very severely,
   (c) the ship may strike a fender unit; it may overcome the resistance of the unit and still damage the jetty upper-works.
4. The solid type jetty needs either no fendering or that of the type used in Dublin, as it is not vulnerable to any degree, no matter how struck by a ship.
5. The solid type jetty as now being built in Dublin can be constructed much more economically than any other type of deep water quay or jetty and considerably cheaper than the open type for similar purposes.
6. This being so, it was felt that in some cases where the open type with shock absorbing fenders have been built, consideration might have been given to the solid type with consequent economies.

There is no doubt in the minds of many port engineers that it is in the interests of port authorities to construct rigid berths which will have the effect of causing vessels to approach with greater care. But this is a view which must, in the course of time, give place to a broader outlook which considers the economics of port operation and shipping together as one problem.

Communication 4 of Section II dealt with dredging, and in the course of the ensuing discussion, Mr. Buckley gave an account of an under-water rock breaking device recently introduced in the Port of Dublin in connection with the deepening of berths at a new mass-concrete quay wall. Briefly, it consisted of dropping, from two cranes mounted on a large pontoon, breakers weighing nearly four tons each. The breakers were made up of a framework of mild steel angles, plated inside at the top and pyramidal below, tapering to a point consisting of a steel pile shoe. The breaker was slung from the crane wire through a swivel, a 12-in. ring and a 4-legged wire rope sling attached to the top corners of the breaker by shackles on to steel plate lugs. The breaker was then hoisted as far as possible by the crane and the winch taken out of gear and the barrel brake released. The breaker then dropped overhauling the wire and barrel and received very little checking force. About eight or ten blows of the breaker were given at each spot, the spacing of the spots being approximately 4-ft., parallel to and normal to the quay face. The results were very satisfactory and the costs far below estimates received from other sources.

The courtesy and hospitality of the Italian hosts should be placed on record. Apart from the vast amount of organisation required for the success of the official business of the Congress much care and thought had been given to arrange the social activities so liberally provided. One of the most valuable features of the Congress was the opportunity delegates had of making so many new acquaintances from many parts of the world. This resulted in free exchange of views and knowledge on a large number of subjects connected with port engineering and operation.

There are, however, one or two matters to which the organisers might give consideration before the next Congress meets. Arrangements for the simultaneous translation of speeches into different languages were excellent, but the value of this service was somewhat impaired on a number of occasions when delegates spoke so rapidly that the interpreters were unable to give an adequate translation. It is suggested that delegates should be co-opted for translating French-English and vice-versa, not so much for their linguistic ability as for a knowledge of the fundamentals of the technical opinions expressed. The literal translations are not always completely intelligible and rarely achieve the desirable standard of technical expression.

The discussions generally were full of interest though disappointing in regard to the small number who spoke. One great fault lay in the time taken by the Compiler to read the report (which most members of the Congress had received prior to attending the meeting) so that little time was left for discussion. The permanent committee might well consider some manner by which more members could be encouraged to take part in the discussions and the addresses made shorter. Another matter calling for comment was the delay in the issue of translations of the conclusions. The American representative met with the approval of most of the members when objecting to vote on a conclusion, the draft of which he had not seen.

These criticisms are not intended in any way to detract from the value of the Congress which was voted an unqualified success.

It is a matter for considerable regret that more officials of the Dock and Harbour Authorities in the United Kingdom are not permanent members of the International Navigation Congress. There is no doubt that the attendance of men accustomed to handling large vessels in and out of harbours and docks, and their opinions on the many matters discussed, would be most welcome. The name of the Congress itself, " International Congress of Navigation," with its two sections, one dealing with Inland navigation and the other with Maritime navigation, should surely rouse the interest of officials connected with the design, construction and operation of Ports and Harbours.

U.K. Ports Traffic.

According to the " Board of Trade Journal " the total net tonnage of vessels in the foreign trade entering United Kingdom ports with cargo in October was 24,000 tons lower (7 per cent. on daily average basis) than in September, but higher than in October of last year. Entrances totalled 5,898,000 tons compared with 5,259,000 in October, 1952, an increase of 12 per cent. in the daily average. Tonnage cleared amounted to 4,452,000, compared with 4,183,000 a year earlier—an increase of 6 per cent. The October figures were 3 per cent. down on September. The net tonnages of arrivals and departures with cargo in the coasting trade were little changed compared with September, but compared with October of last year arrivals were 5 per cent. higher and departures 4 per cent. higher.

The Docks of London

Evolution of the Modern Dock System

By W. P. SHEPHERD-BARRON, M.C., T.D., M.I.C.E.

THE presidential address of the Institution of Civil Engineers was delivered on 3rd November last, by Mr. W. P. Shepherd-Barron, president for the session 1953-54. His subject was the historical development of the Port of London.

After tracing briefly the evolution of London's dock systems and the salient features connected with their construction up to the end of the nineteenth century, Mr. Shepherd-Barron said that, at about that time, it became apparent that there would be great financial difficulty in securing further dock expansion by the Companies and that in order to render this of value, and indeed to obtain the best use of existing accommodation as well as to cater for larger shipping, it would be necessary to deepen the river channels.

Shipping was growing rapidly in size and an era of dock expansion on an even larger scale than before was about to begin in all the major ports of the United Kingdom as well as abroad. In 1900, this matter came before Parliament. The Government attitude was represented by the President of the Board of Trade, Mr. C. T. Ritchie, afterwards Lord Ritchie of Dundee, the result being the appointment of a Royal Commission of Inquiry. The eventual outcome was the constitution by Act of Parliament of the Port of London Authority, which, in 1909, under the Chairmanship of the Rt. Hon. Viscount Devonport, P.C., took over the assets of the Dock Companies and assumed the management of the port, including the docks and the river below Teddington, the latter having been formerly vested in the Thames Conservancy.

The first Chief Engineer of the Port, Mr. (later Sir) Frederick Palmer, K.C.M.G., C.I.E., Past-President I.C.E., immediately formulated outline schemes for dock improvement and new construction, which, in large measure, have been followed broadly during the ensuing years, and which were complementary to the extensive deepening of the river and estuary down to the Nore, by dredging.

Various improvements were soon put in hand. At London Docks, the passage between the Western and Eastern Docks was widened, the jetty in the Western Dock was reconstructed in reinforced concrete with a double-storey warehouse, and new double-storey brick and reinforced concrete warehouses were built on the north quay, which was widened. The Hermitage Entrance was closed and an impounding pumping station built therein, enabling the water level in the dock to be raised to 3-ft. 9-in. above T.H.W.

At the West India Import and Export Docks the north quays were widened by 56-ft. and 20-ft. respectively, by the construction of open or "false" quays consisting of reinforced concrete cylinders with piles driven therein surmounted by reinforced concrete beam and slab decking, with precast bracing set into the old walls. This enabled the docks to be deepened by 3-ft. to 26-ft. below T.H.W., the bottom sloping down under the open work. Since the old walls were founded on the ballast their stability was not endangered by this procedure, which has since been repeated elsewhere and which has proved a remarkably effective and economical method of achieving greater depth in the docks without reconstructing the older walls. The ballast once again proved its immense value as a foundation material.

New brick and reinforced concrete warehouses were built on the north quay of the Import Dock, partly over the false quay, and new steel transit sheds were erected. False quays and new sheds were also built and the lock from the basin was reconstructed, 300-ft. long, 80-ft. wide, and 31-ft. deep below T.H.W. A new impounding pumping station raised the water level in the Import Dock by 2-ft.

The Millwall dry dock was lengthened to 546-ft.

At the Royal Albert Dock, a new impounding pumping station was built and the water level in this dock and the Royal Victoria Dock raised by 2-ft. 6-in. The Western Dry Dock was lengthened to 574-ft. 6-in. and widened to a minimum of 82-ft. at the entrance. On the north side of the Royal Albert Dock the first electric quay cranes were installed.

At Tilbury Docks, where the demand for berthing accommodation had increased, the first stage of a scheme of extension westward of the Main Dock was undertaken. The south quay was lengthened by 1,531-ft. with a return section at the west end. The dock was correspondingly lengthened, with a depth of 42½-ft. and a bottom width of 300-ft. The very soft marsh clay, which could not be drained owing to the proximity of the existing dock, made it impossible to sink trenches from the surface, within which to construct the ordinary type of gravity dock wall. This was therefore formed with monoliths 30-ft. square, each with four wells, built from mass concrete blocks and sunk to the ballast; the back wells were filled with concrete and the front ones left empty. The new quay, which is 40-ft. wide, was equipped with three steel and corrugated iron transit sheds, 120-ft. wide and about 600-ft. long, with a continuous railway platform at the back, and also with electric quay cranes. The Contractors for the works were Topham, Jones and Railton Ltd.

The largest of the dock extensions undertaken by the Port Authority was the construction of the King George V Dock, to the south of the Royal Albert Dock, and connected thereto by a cutting. This magnificent dock was commenced in 1912, the Contractors being S. Pearson and Sons. In the same year, Mr. (later Sir) Cyril Kirkpatrick, Past-President I.C.E., succeeded Mr. Palmer as Chief Engineer, and Mr. Palmer was retained as consultant to the Port Authority.

The dock is 4,500-ft. long, the width being 630-ft. at the eastern end tapering to 450-ft. at the western end, and the depth is 38-ft. below impounded level, which is 2½-ft. above T.H.W. At the eastern end, a new lock entrance was built, 800-ft. long, 100-ft. wide, and 45-ft. deep below T.H.W. to the three sills, with a large bellmouth approach from the river formed beyond the lock walls by two massive timber leading-in jetties. The lock is provided with buoyant steel gates fitted with crocodiles and rollers and worked by hydraulic rams.

The lock structure and the dock walls were of mass concrete and founded on the ballast or the chalk. At the western end, a dry dock was built, 750-ft. long, 100-ft. wide, and 35-ft. deep below impounded level. The dry dock was equipped with a floating ship-type caisson, an electrically-driven pumping station, and a 25-ton dock-side crane.

On the south side of the dock seven reinforced concrete dolphins, 500-ft. long, were constructed to carry electric quay cranes; they left a water space 32-ft. wide between the wall and the back of the jetties to accommodate barges. On the north side, six double-storey warehouses were built of brick and reinforced concrete, with steel roofs and underslung electric travelling cranes. On the quay are electric cargo cranes. Seven single-storey steel transit sheds were built on the south quay, and the entire dock is served by railways and vehicular roads. The First World War occasioned much delay and the dock was finally completed by the Port Authority in 1922, the total cost being £4,130,000.

At Tilbury, a cargo jetty was constructed in the river, 1,000-ft. long and 50-ft. wide, on three rows of reinforced concrete cylinders with piles therein, connected by precast bracing and two heavy reinforced concrete decks, the space between being used as a transit shed. Electric quay cranes are mounted on the top deck, which also carries two railways. The jetty, which was completed in 1921, is connected with the shore by a curved approach. At the outer side a depth of 50½-ft. below T.H.W. has been provided and the inner side is used by small vessels and barges.

At the western end of the north side of the Royal Albert Dock, three of the transit sheds were replaced in 1920 by a double-storey brick and reinforced concrete building with a steel roof, 1,100-ft. long. The ground floor is used for transit purposes and the upper

The Docks of London—*continued*

PARTICULARS OF DOCKS—PORT OF LONDON AUTHORITY

Dock group	Distance below London Bridge : miles	Totals: Area of estate : acres	Totals: Water area : acres	Totals: Length of quays: miles	Docks	Max. depth : feet	Max. W.L. above T.H.W: feet	Lock entrance: Length : feet	Lock entrance: Min. width : feet	Lock entrance: Depth to centre of sill below T.H.W: feet	Dry docks: Length: feet	Dry docks: Min. width : feet	Dry docks: Max. depth depth over blocks : feet
St. Katharine . .	0·66	25	10·10	0·94	Basin	18		180	45	28 outer			
					Western	18				24 inner			
					Eastern	18							
London . . .	0·86 to 1·94	100·25	34·67	2·97	Hermitage Basin	25·25	3·75						
					Wapping Basin	23	3·75	170	40	23			
					Western	23·75	3·75						
					Tobacco	24·75	3·75						
					Eastern	24·75	3·75						
					Shadwell Basin	25 and 28	3·75	350	60	28			
Surrey Commercial	1·81 to 3·56	381·50	134·48	8·88	Basin	27		250	50	27·25			
					Albion	27					88·25	22.5	7·25
					Canada	27							
					Quebec	27							
					Russia	19							
					Island	23							
					Stave	19 and 21							
					Lavender	19							
					Lady	19							
					Norway	19							
					Greenland	32·5		550	80	35·25			
					South	27		220	48	27			
West India and Millwall	2·80 to 6·31	466	132·88	6·71	Import	26 and 29							
					Blackwall Basin	26		480	60	30			
					Export	26							
					Junction	25							
					South Millwall	29		584	80	35			
					Inner	29							
					Outer	28		450	80	28	546·42	65	24·12
East India . .	6·71	49	23·34	1·16	Basin	32		100	64·5	31			
					Import	24	2						
Royals	7·1 to 10·59	1112·5	235·85	11·05	Royal Victoria	28 and 31	2·5	325	80	20·5			
					Royal Albert	29·5 and 34	2·5				574. 5	80	22·75
											500	62	22·75
					Royal Albert Basin	34·5	2·5	550	80	30			
								550	80	36			
					King George V.	38	2·5	800	100	45	750	100	35
Tilbury . . .	24·78 to 26·22	725	103·79	3·95	Basin	Tidal		695	79·5	44 outer	260·5	59·83	26·83 (T.H.W.)
										38 inner	119	70	31·75 (T.H.W.)
					Main	38					560	59·83	26·83
											698·3	70	31·08
											752·3	110	37·5
					East Branch	38							
					Centre Branch	38							
					West Branch	38							
					Main Dock Extension	42·5		1,000	110	45·5			
Totals		2,859·25	675·11	35·66									

floor, which is divided into four sections, is insulated and refrigerated. Adjacent to this, a large six-storey brick and reinforced concrete cold store was built in 1918. The total refrigerated space at the Royal Docks was then increased to about 4 million cubic feet, which is equivalent to a storage capacity of nearly 1 million carcases of mutton.

The dock-side cold floor was intended for sorting prior to conveyance to the store on elevated bands, but it was found to be more economical to sort to rail wagon for conveyance to the store. The upper floor of the shed was not therefore used as refrigerated space to any extent until the Second World War and since.

Very large warehouses were also built on the north side of the Royal Victoria Dock, between 1920 and 1924, for the storage of tobacco, and two berths were reconstructed on cylinders and piles and equipped to handle chilled beef.

At the Surrey Commercial Docks, a scheme was formulated for a large new dock to cross the middle of the estate and, possibly, a new entrance lock some distance above the Greenland Entrance. The first stage of this, the Quebec Dock, was undertaken in 1923 on the site of the Quebec, Canada, and Centre ponds.

An 80-ft. wide cutting was formed from the east side of the Canada Dock and a triangular-shaped dock was constructed between this point and the Russia Dock. A north wall, 1,300-ft. long, and a south wall, 900-ft. long, were built, the eastern end being left as a slope to allow for future extension. The walls were all founded deep enough to permit the cutting and dock to be deepened to 35-ft., but the depth was restricted to 27-ft. in the first instance. Large timber storage sheds were built similar to those previously built at the Canada Dock and elsewhere. These have open ends and brickwork fire division walls with light steel roofs, and enable timber to be stacked to a height of about 25-ft.

The Lavender and Acorn Ponds were reconstructed and deepened to 19-ft. below T.H.W., with a steel sheet piled wall on the east side, 1,670-ft. long. The Stave Dock—Lavender Dock

The Docks of London—*continued*

passage was widened to 55-ft., and deepened to 23-ft. The old Lavender Entrance was closed and an impounding station built therein.

In 1925, Lord Devenport retired and was suceeded as Chairman of the Port Authority by the Rt. Hon. Lord Ritchie of Dundee, whose father had been so prominently connected with its inception.

In 1926, a large scheme of development at Tilbury Docks was put in hand, consisting of the construction of a new entrance lock at the western end of the Main Dock, which was also widened, and of a new dry dock, at a total cost of £2,460,000. The lock was made 1,000-ft. long, 110-ft. wide, and 45-ft. 6-in. deep to the three sills below T.H.W., and was equipped with three pairs of ram-operated tank gates. The lock was aligned at an angle with the river—unlike all the other entrances of the Authority's docks (excepting Shadwell and Surrey), which are almost at right angles to the line of the river. Massive timber leading-in jetties were also built to form a bellmouth entrance.

The dry dock at the eastern end of the Main Dock was also set at an angle to facilitate the entry of large ships and was made 750-ft. long, 110-ft. wide at the entrance, and 37½-ft. deep below T.H.W.

These structures were formed by means of monoliths, which have proved to be a successful mode of construction under the conditions prevailing at Tilbury. New impounding pumps were installed in conjunction with the dry dock pumps.

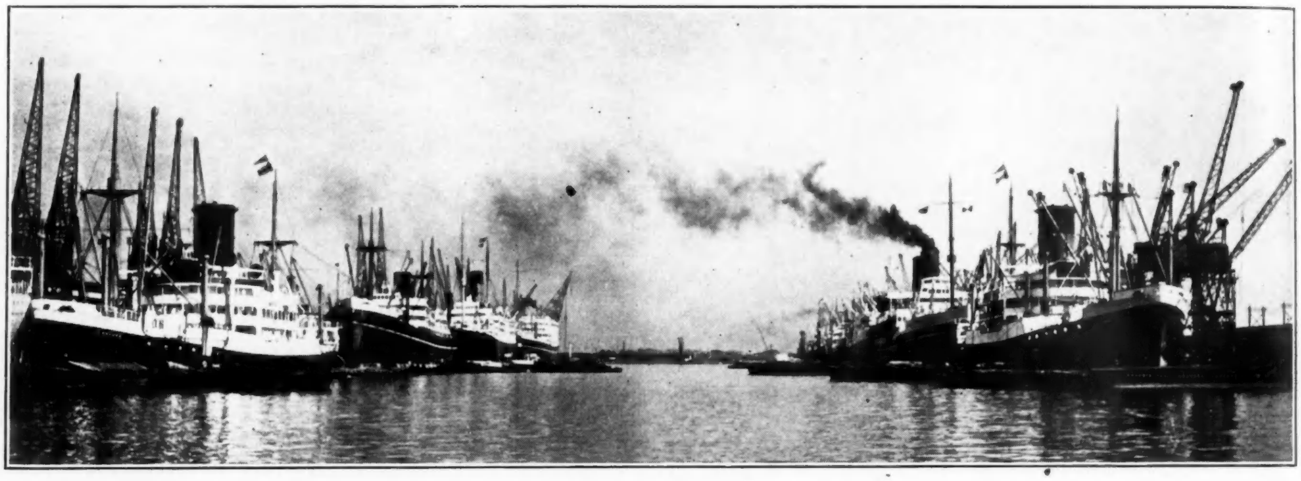
The Port Authority also provided excellent new facilities for passengers by means of a floating landing stage, 1,142-ft. long, moored in the river to dolphins immediately below the entrance to Tilbury Basin, together with a large baggage hall for Customs examination, adjacent to Tilbury Riverside Railway Station. A length of 300-ft. of the stage is segregated for cross-river ferries. Covered gangway bridges connect the stage with the hall. Passenger liners, whichever of the dock systems they may berth in, now call regularly at the stage on passage both inwards and outwards.

At the same time, at the West India Docks, the South Dock ship entrance at the eastern end was entirely reconstructed, the new lock being made 584-ft. long, 80-ft. wide, and 35-ft. deep to the three sills below T.H.W. New passages were also constructed to connect the Import, Export, and South Docks, and the latter with the Millwall Inner Dock; a new impounding pumping station was installed at the west end of the South Dock. All these works were carried out in sheet-piled and timbered trenches with mass concrete construction and cost, in the aggregate, £1,650,000.

When the late Mr. Asa Binns, President-Elect in 1946, was Chief Engineer, further schemes of improvement were formulated and some of the works put in hand. The principal of them were at the Royal Docks, where the Royal Albert Dock was deepened to 34-ft. below impounded level, except at the south quay and a false quay, 19-ft. wide, was constructed on the north side.

The Royal Victoria Dock was almost entirely remodelled. Its depth was increased to 31-ft., including the invert of the cutting between the Victoria and Albert Dock; a new quay of open-cylinder and sheet-piled type was constructed at the western end of the south side to replace a dilapidated timber wharf, and at the eastern end the dock was widened and two new monolith quays were built in conjunction with the erection of a large flour mill by tenants. Three other large flour mills, with dolphin or quay-wall berths, had, in pre-war years, also been built by tenants on the south side of this dock.

On the north side, the old jetties were beginning to fail by the corrosion of their tie-rods and the sheds had long proved inadequate. In consequence the jetties were cut back and a new straight open-type quay, 3,300-ft. long, was built. It consisted of three rows of reinforced concrete cylinders with piles and a heavy beam and slab superstructure with sheet piling at the back. The spaces behind this quay were reclaimed by pumping with ballast dredged from the dock, and on the ground thus formed five large three-storey warehouses were built together with railways and a new vehicular road. The total floor area of these warehouses is 26 acres.



General view of Shipping, King George V Dock.

The total cost of these improvements was £1,850,000 and various similar but smaller improvements were carried out at the West India, Millwall, and Surrey Commercial Docks.

The war put a stop to further improvements and indeed was the cause of an immense amount of widespread damage and destruction. Much of this was the result of fire among the older timber-floored warehouses at the upper docks and the timber in store at the Surrey Commercial Docks ; there was also a great deal of damage by high-explosive.

In 1939, Lord Ritchie retired, and his successor, the Rt. Hon. Thomas Wiles, P.C., in 1946. The present Chairman of the Port Authority, the Rt. Hon. Viscount Waverley, P.C., G.C.B., G.C.S.I., G.C.I.E., F.R.S., and Honorary Member of the Institution, took office in 1946.

Very rapid strides have been made with the repair and reconstruction of the docks and buildings and the opportunity has of course been taken to do so on the most up-to-date lines and to effect as much improvement as possible.

Besides this, further large works of development are in hand, principally the reconstruction of the lower entrance lock of the Royal Albert Dock, the construction of a new quay and shed on the north side of the Main Dock at Tilbury and of warehouses at West India Dock, and the widening of the Canada-Greenland Cutting at Surrey Commercial Docks.

Analysis

In conclusion Mr. Shepherd-Barron referred to the size and growth of the shipping for which all these vast dock works have been

The Docks of London—*continued*

constructed and which will be the all-important factor in the design of future works.

The largest vessels using the port at the commencement of the nineteenth century were East Indiamen of 1,550 tons burthen 199-ft. long and 43½-ft. beam, but they were exceptional and the majority of the vessels were of 300-400 tons burthen. Ship sizes tended to decrease after the end of the Napoleonic Wars and it was not until 1838 that a larger ship was built, this being the trans-atlantic wooden paddle-steamer "British Queen"—2,016 tons, 234-ft. long and 37½-ft. beam. In 1853 the P. & O. Company launched their iron screw-steamer "Himalaya"—3,437 tons, 340-ft. long, and 44½-ft. beam.

During the second half of the nineteenth century, the size of shipping increased steadily and so consequently did that of the lock entrances which were required. Comparison of the tonnage of old vessels with ships of today is made difficult by the changes in the rules of measurement, for until 1835 tonnage was calculated on an empirical formula which disregarded both depth and fineness; from 1836 to 1854 a simple volumetric rule was in use and

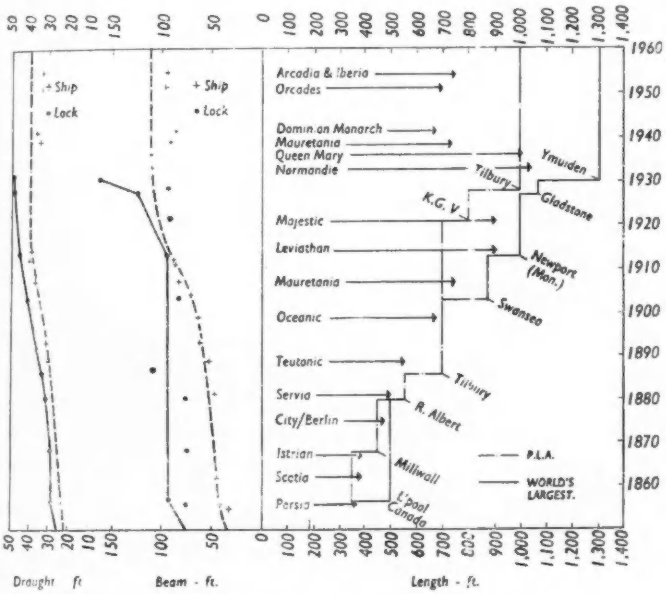


Diagram showing Lock and Ship Development from 1850.

it was not until 1855 that the basis of the present volumetric system was established.

The diagram shows the dimensions of certain of the largest ships at various dates since then and also of certain of the largest ships for which the Port of London has had to provide during recent years. It also shows the dimensions of the lock entrances constructed at the docks during the same period, together with those of the largest locks built for commercial shipping throughout the world.

It will be seen that the London entrances have, except for the very largest north Atlantic passenger liners, always been not only adequate for the largest ships trading to London but have provided a considerable margin at the date of their construction; in some cases, however, the size of shipping has eventually outstripped that of the entrances.

The Upper Entrance at Tilbury, although built in 1928, still provides a good margin, especially in length, over the largest present-day vessels of the P. & O. and Orient Lines, and the King George V. Entrance, now 30 years old, has on one occasion accommodated the present R.M.S. "Mauretania," which was built to conform with the dimensions of this entrance; the next largest ship which regularly docks at this entrance is the "Dominion Monarch" of the Shaw, Savill and Albion Line, for which there is a good margin.

Analyses of shipping at the Royal Docks and at the West India Docks, made a few years ago, have shown that the number of vessels of the largest sizes are small by comparison with the total and that a second entrance of more moderate dimensions than the largest is a very valuable asset at a dock system, since it enables more shipping to be docked on a tide and conserves impounded water. For instance, it was found that, from consideration of size alone, the Gallions Lower Entrance of the Royal Albert Dock could have locked as much as two-thirds of the number of ships using the Royal Docks and a somewhat similar proportion could have been locked at the Blackwall Entrance of the West India Docks; it is seldom if ever possible economically to justify the provision of two entrances of the largest size at a dock system, but on the other hand it is of the utmost importance that the dimension of such entrances should be determined from a careful and generous estimate of the sizes of the largest classes of ships that will be built in the future for the trade of the dock.

Once built, these structures can seldom be altered, except at very great expense, and the additional cost of providing a good margin is relatively not great. Past history shows that, in every case, planning in this way has been fully justified. The cost of ships and the value of the cargoes they carry are today so great that the capital cost of adequate port works, while very heavy, is not unduly large by comparison and may be fully justified in the national interest by the economies that the larger ship effects by reduction in running and transportation costs.

An important matter in the determination of the dimensions of entrances is the relationship of beam to length of ships and this has altered considerably during the past 50 years. Existing port works both at home and abroad have often imposed limitations upon the increase in the size of ships, especially of length, by reason of locks and berths available, and of draught by reason of the depth of channels, which often are difficult and costly to deepen.

The only freedom available to the shipbuilder, therefore, has been in beam; this may be related to length by the formula:

$$\text{Beam} = \frac{\text{length}}{10} + C$$

The value of the factor C was about 7 in 1900 but has steadily increased and is now sometimes as high as 19 and, may even increase to about 24 in the future.

The question of "depth of water to be provided in sea ports, their entrances and berths in relation to the present trend in shipbuilding as regards dimensions and speeds of large ocean-going liners, cargo ships and tankers" is at present being studied by the Permanent International Association of Navigation Congresses, on the British National Committee of which the Institution is represented.

When formulating his proposals for the improvement of the Port Authority's Docks in 1910, Sir Frederick Palmer had these considerations prominently in mind and in his comments expressed his only fear, which was that he might repeat the former mistake of building certain entrances too short for future requirements. He considered that such mistakes had repeatedly hampered shipowners in the size of vessels necessary for their trade and could involve very heavy expenditure in reconstruction which could not give the same advantageous results as the original provision of adequate large entrances. His foresight and that of the Port Authority in building the magnificent entrances he designed have been amply justified.

Safety Bill for U.S. Dock Workers.

A Longshoremen's Safety Bill sponsored by the International Longshoremen's Association has again been introduced into the United States Senate after having been defeated during the last few sessions of Congress.

The Bill seeks to strengthen the existing legislation, which at present merely provides for voluntary safety regulations and government recommendations on practices and procedures, with no provisions for enforcement. Violators of the prevailing regulations and recommendations cannot be prosecuted, and there is little tendency on the part of employers to implement safety measures voluntarily. As a result, U.S. Labour Department statistics show that the longshoreman's occupation is the third most hazardous with respect to severity of injuries and the fifth most hazardous with respect to their frequency.

New Zealand Waterfront Industry

Annual Report of Commission

The annual report of the New Zealand Waterfront Industry Commission for the year ended 31st March last, states that the year under review was the most peaceful since the establishment of Commission control in 1940 and for many years prior to that date. The serious congestion of shipping which occurred at New Zealand ports both prior and subsequent to the strike was overcome during the year and vessels are now being turned around without delays through shortages of berths or labour. The total cargo handled at New Zealand ports for the year ended 31st March 1953 was 9,978,000 tons, as compared with 9,660,000 tons for the year ending 31st March 1952 (strike year) and 8,348,000 tons for the year ending 31st March 1951. The marked reduction in imports during the latter part of the year resulted in periods of slackness of employment and increased the cost of daily and and weekly guaranteed wage payments to watersiders.

The Bureau register strengths at the various ports have remained constant at approximately six thousand, and waterfront work is being performed by one thousand less workers than were employed prior to the strike. There has been a further increase in the rate of work during the year with a corresponding increase in bonus payments under the co-operative contracting system. Harmonious relationship exists between the employers and the workers and between the Commission and both parties.

Except at the port of Wellington where there are two unions, old and new watersiders in the various port unions are working side by side without friction. At Wellington there is still some friction between old and new watersiders and it has been necessary to engage and pay them at separate places and not to employ them on the same vessel. There are other difficulties in amalgamation of the two unions in that members of the Wellington Maritime Cargo Workers' (Permanent) Union which consists of new watersiders, are working under an agreement with the employers which provides for their permanent employment at a weekly wage while the members of the Wellington Waterfront Workers' Union (old watersiders) are employed on a casual basis. The workers in permanent employment have preference of employment over those engaged on a casual basis. The amalgamation of the two unions would overcome a number of administrative problems that now exist and would also enable a better utilization to be made of the available labour at the port.

Agreement has been reached between the employers' and workers' organizsations for a revision of the Commission's Main Order. The agreement which operates from 31st August 1953, gives effect to a number of recommendations of the Waterfront Royal Commission and provides for greater mobility of labour. The agreement will increase efficiency in the industry.

No difficulty was experienced by shipping companies in providing sufficient refrigerated space for the prompt shipment of dairy produce and meat during the year. There were no serious delays to shipping during the year through shortages of labour. In the earlier part of the year there were occasions when additional men could have been employed at certain ports during peak periods of shipping, while during the latter period of the year, due to a reduction in cargo tonnage handled, there was generally a surplus of labour at most ports.

Turn-round Times.

The report includes statistics with regard to the turn-round of oversea vessels at New Zealand ports which show that the 103 vessels which discharged and loaded averaged 68.25 days on the coast. Cargo was worked on an average of 44.98 days and the balance of the time was due to Sundays and holidays (11.53 days), steaming time between ports (1.44 days), awaiting berths 8.61 days), awaiting labour (0.23 days), ship repairs (0.4 days) and miscellaneous delays (1.06 days). The 29 vessels which loaded only averaged 26.31 days on the coast. Cargo was loaded during 20.86 days. An average of 369 tons of cargo was discharged per ship working day, and an average of 355 tons was loaded per ship working day, the overall average being 362 tons. The best average was at Auckland, where 445 tons of cargo were handled per ship working day. For the 103 vessels which discharged and loaded, the average cargo handled per vessel was 1[illegible],596 tons. The 29 vessels which loaded only averaged 6,364 tons.

The Commission point out that the average loss of approximately nine days per vessel through awaiting berths was largely due to the serious congestion of shipping during the earlier part of the year. This has now been overcome and oversea vessels are now being turned round without delays in awaiting berths.

The average hours worked per registered worker for all ports for the year was 43¾, compared with an average of 44[illegible] hours in the previous 12 months. The average wage per man-week at all ports increased from £15 0s. 5d. in 1951-52 to £15 17s. 5d. for 1952-53. The average profit distribution per man-week for 1952-53 was £2 15s. 6d., which is included in the weekly average. The highest weekly average—£17 13s. 5d.—was earned by members of the permanent union at Wellington, while the average for the members of the casual union was £13 19s. 8d. The average at Auckland was £17 10s. 6d. per man-week.

Prevention of Pollution of the Sea by Oil

Tank Cleaning and Oily Water Reception Plant at Falmouth

The pollution of the sea by oil has been a subject of concern to Harbour Authorities for over thirty years. The seriousness of the problem was recognised by the British Government in 1921, resulting in legislation in the form of "Oil in Navigable Waters Act, 1922," but it is since the 1939-45 war that the enormous increase of oil has made the gravity of the situation much greater.

The erection of large refineries, both in the United Kingdom and in Continental ports, has been brought about by the increase in oil cargoes, particularly in the transport of crude oils. This type of oil, with the heavy waxy sludge which it leaves in the cargo tanks after discharge of cargoes, has been the main cause of pollution of the sea and coast-lines of Great Britain and in Europe generally.

It must be borne in mind that the procedure has been and, in many cases, still is, that after a vessel has discharged her cargo she would proceed to sea, washing tanks en route in preparation for arrival in a clean condition at the next port of call. This requires up to an additional forty-eight hours at sea at the end of each voyage. The tank washings and oily ballast water are pumped overboard, together with a waxy content in lumps of varying sizes. It has been these lumps, carried in by the tide, that have been largely responsible for the fouling of the beaches and affecting the amenities of seaside resorts, as well as being a nuisance to fishing boats and yachts and causing the destruction of and injury to sea birds and many forms of marine life.

In Falmouth the limitations of the small barge type separator for dealing with these tank washings direct from a vessel, were appreciated some years ago, and in order to provide a lasting solution it was decided that a large shore plant had become necessary. Consideration of this, interrupted in 1939, was resumed in 1946 and after exhaustive experiments and by the process of trial and error into the various aspects of the matter, the principle of the plant was eventually evolved as set out hereunder.

The plant had to be isolated from the other facilities in the port for safety reasons and had to be adjacent to a suitable quay where vessels could come alongside direct from their last port of call.

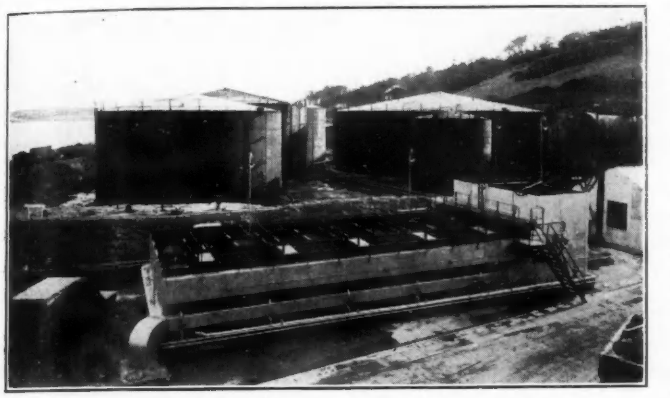
The method of preparation of the ships' tanks before arrival at Falmouth has varied according to the views held by the different tanker companies. Some ships have transferred the drainings from their main tanks to slop tanks. Other ships have ballasted their tanks with sea water. The disposal of both slops and large quantities of oily ballast water is dealt with in the same manner. All are passed through the shore separator.

Late in 1951 the Falmouth plant was completed, with pipelines direct from the berth to the separator, the whole plant being designed to deal with a pumping rate from ship to shore of one thousand tons per hour. There are three tanks of a total capacity

Prevention of Pollution of the Sea by Oil—continued

of some six thousand tons which are used for the reception of oily slops, etc., for settling and dehydration.

The essential feature of the plant is the Victor Oily Water Separator, into the design of which has gone nearly thirty years of experience gained in producing many hundreds of separators which have been fitted to all classes of vessels of the leading shipping companies of the world. Many owners have fitted the apparatus to their vessels from as far back as 1922 when oil pollution from vessels burning fuel oil threatened to become an international problem, but on a smaller scale than that which exists to-day. This separator, of the Multi-Weir Gravity Flow type, is divided into compartments or bays by a series of weirs, where the velocity of flow is gradually reduced. This deceleration causes the liquid



General view of Tank Cleaning Plant at Falmouth.

slowly to give up the oily particles and the separated water to run into the sea. The watery oil is then further treated in the tanks by the application of heat for de-watering, and by settling, the separated water being discharged into the sea. This discharge, both from the separator and from the processing tanks, is well within the permissible percentage laid down in the "Oil in Navigable Waters Act." It should be appreciated that as the sludge is a waxy residue, the temperature of the material must be maintained by heating coils in order to make it pumpable.

Quite apart from the waxy residue there is, in addition, an accumulation of unpumpable scale, sand, and mud. This material is also covered with oil and wax, and provision is made in the Falmouth plant for it to be collected by hand. It is then removed into a special treater tank and thereafter, by the application of steam and slight agitation, is separated from the oil and wax in a condition where it is fit for ground-filling. The separated oil and wax from this material are, of course, processed in the normal way.

From its inception in December 1951, to the present date, the plant has handled over 150 ships of various sizes and carrying different cargoes, which have been cleaned speedily and with the utmost efficiency and over half a million tons of oily ballast water and tank washings have been passed through the separator.

As a further aid in the tank cleaning process, use has been made of the latest development in tank washing machines, that is, the Victor Pyrate Machine, which embodies a triple nozzle from which hot water is ejected at high pressure on to all the internal structure of the tank. It is believed that the combination of these two Victor products, the separator and the Pyrate machine, is the complete answer to quick and efficient tank cleaning.

The foregoing description has, of necessity, omitted any detailed and technical data of each section of this extensive plant but endeavours to show that Falmouth has the complete solution to the problem which has exercised so many minds, both lay and technical.

Civil Engineers' Diary. Published by Wm. Collins Sons & Co., Ltd., Glasgow.

This diary, which has been asked for for many years, contains a vast amount of practical and useful information which will be found of interest and value to every Civil Engineer. Copies are obtainable from all stationers and booksellers. Price 4s. 8d. without pencil, and 5s. 3d. with pencil.

Book Reviews

The Transport Act 1953: An Explanation for the Transport User and Operator, by H. S. Vian-Smith. Published for *Motor Transport* by Iliffe and Sons, Ltd. Price 12s. 6d. (by post 13s.).

The Transport Act of 1953 not only reverses the main provisions of the 1947 Act, which removed from private control a large part of the British Road transport industry, but also amends and repeals statutory provisions going back over a period of more than a century. It is, therefore, legislation of exceptional importance to all executives in this industry and to most users of inland transport, and this short explanation of the Act has been written especially for their guidance.

The author, as Secretary of the Home Affairs and Transport Division of the Association of British Chambers of Commerce, was closely concerned with the passage of the Act, from its conception to its receiving the Royal Assent. As a representative of industry, he took an active part in the discussions with the Government which led to its final shaping, and few people are better qualified to explain the purpose of its most important sections.

The book avoids, as far as possible, the use of legal phraseology, the aim being to make clear to the layman the full intent and meaning of each section of the Act. Footnotes provide references to all other legislation concerned, and the book is both fully indexed and arranged so as to facilitate rapid reference.

Battery Chargers and Charging, by Robert A. Harvey, B.Sc. (Eng.), A.M.I.E.E. Published by Iliffe and Sons Ltd. 400 pages. Price 35s. net (postage 1s. 2d.).

There has been steady progress in the design of storage batteries over the last twenty-five years, but during this same period there have been fundamental changes in the methods used for batttery charging and control. This book describes all these new methods together with the older methods which are still in current use, showing how battery control problems have been solved in many industries.

The construction and chemistry of each type of storage battery is first explained, and there is a description of the fundamental principles of charging, together with much general information on charging technique. The book then describes how the principles are used in various specialized applications. These include electric vehicles and locomotives, emergency lighting and power systems, power stations, telephone exchanges, mines, ships, aircraft, railways, trolley buses, cars and commercial vehicles, and generating plant for country houses and other isolated buildings.

The work is fully illustrated by more than 280 drawing and photographs. The diagrams throughout are simplified as far as possible, the intention being to make clear the basic principles used in each case rather than to go into unnecessary detail.

The book will be of interest to all concerned with the installation, operation and maintenance of battery charging systems in any field, and particularly to engineers considering new or unfamiliar applications.

Cathodic Protection of Pipelines and Storage Tanks, by V. A. Pritula. Published for the Department of Scientific and Industrial Research by Her Majesty's Stationery Office. Price 10s. (2 dollars 25 cents U.S.A.) by post 10s. 6d.

Corrosion of underground water pipelines alone is estimated to cost the United Kingdom at least £5 millions each year.

One of the ideas for combating this corrosion which has been investigated in Britain and other countries is cathodic protection. This is a method of using small electrical currents which divert the effects of corrosion to expendable scrap metal buried nearby. A book on the subject has recently been published in Russia, and an English translation of it is now available.

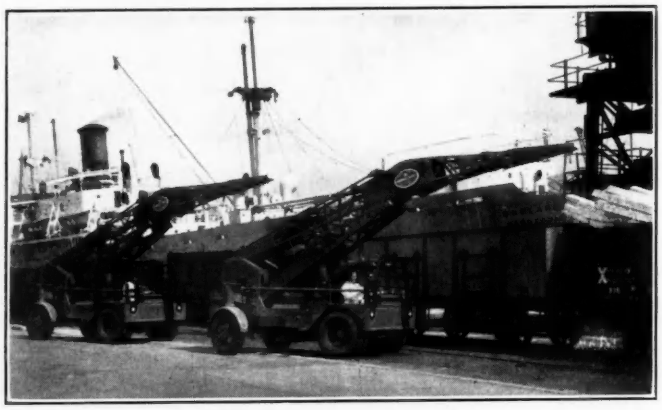
The book, which is liberally illustrated with diagrams, deals with the theory of the subject and provides practical details on the method of carrying out this type of protection. It should be a valuable guide for scientists in industry concerned with this particular problem, and is also a useful manual for those who have to translate theory into practice. Of particular practical help is the attention which has been given to methods of calculation required for various types of installations.

Manufacturers' Announcements

An Improved Mobile Crane

F. Taylor & Sons (Manchester), Ltd., have introduced a new model, known as Mark III, into their range of "Jumbo" hydraulic cranes. The special feature of the new model is an additional hydraulic jack which permits individually controlled movement of the outer jib, independent of the movement of the main jibs. This can be used with lower hydraulic line pressures than the Mark II (articulated jib) model for similar capacity loading.

It is claimed by the manufacturers that the Mark III has other advantages. Independent control of the front jib now permits working under the low ceiling height of 10-ft. $1\frac{1}{2}$-in. The front jib's independent movement gives an additional reach, and the crane hook or other equipment can be controlled fore and aft from



" Jumbo " cranes in operation at Swansea Docks.

the driving seat, without the complete vehicle motion necessary with other models. A further advantage is that a horizontal platform can be fitted and elevated to any required height alongside a ship or close to a vertical wall.

In a confined space loads can be carried closer to the front of the machine, with improved stability for travelling and less overall length for ease of movement. This feature, together with the close turning circles of 14-ft. 6-in. radius, makes its performance compare very favourably with slewing-type mobile cranes even in fairly confined spaces.

Recently " Jumbo " Mark III cranes were employed in loading motor car body sheets 12-ft. by 6-ft. wide at Swansea Docks. Here a mobile type of crane was called for which also would be compact enough to work in the limited headroom of the hold.

Fireless Locomotive for Power Station

The latest fireless locomotive to leave the workshops of W. G. Bagnall, Ltd., Stafford, was recently delivered to the British Electricity Authority. It will be employed in the coal stock yards at the Huncoat power station, Accrington.

The fireless locomotive is similar to the conventional steam shunter except that instead of a boiler it has a steel reservoir which is charged from an outside source. For operation the reservoir is filled with hot water to a predetermined level and then charged with high pressure steam. It is then only necessary to recharge with steam, and this is done by connecting the reservoir to a stationary boiler with a flexible hose. Charging takes 15 to 30 minutes according to the size of the reservoir.

It is claimed that in addition to their low capital cost and high traffic availability, these locomotives are cheap to maintain and operate. The conventional locomotive boiler is expensive to build and to maintain and requires long periods out of service for washing out, fire dropping, tube and ashpan cleaning, etc. This is not the case with the fireless locomotives which can remain in service for 24 hours a day, stopping only for periodic recharging. Driving is simple and the only controls are the regulator, reversing gear and the brake.

The fireless locomotive shares with the Diesel shunter the great advantage of having no stand-by losses. The heavy insulation prevents heat losses when standing, and the locomotive may be left for hours at a stretch and yet be ready for instant service.

These locomotives are popular in places where there is a high fire risk, such as refineries, explosive factories and timber mills. Some have been in service for over 30 years, and one locomotive of this age was recently reported to have hauled 70,000 tons of coal in a week, working 24 hours a day and being charged with steam every four hours.

British Machines for Russia

Russia has placed a large order with the British Straddle Carrier Company of Cambridge for a supply of machines known as the " Timber Wolf," the first machine of its kind to be manufactured in the sterling area. Twenty-five machines have already been delivered, at a cost of approximately £100,000. Several have also been sold to Australia, New Zealand, India, and Ceylon, and enquiries have been received from many other countries.

The " Timber Wolf " Straddle Carrier is a self-loading machine, with a 6-cylinder diesel engine, and is used primarily to transport long, heavy loads to or from docks, goods yards, etc. It is easily handled by one operator and can lift an 8-ton load of 15 yards length in five seconds. The maximum load is 10 tons. It is made in eight standard sizes of load aperture, and has an inside turning radius of 9-ft.

Overseas distribution is controlled by Materials Handling Equipment (G.B.), Ltd., of London.

Exterior Waterproofing of Masonry

The remarkable properties of the organic compounds known as silicone are becoming more widely known. They provide a wide variety of products in the form of fluids, resins, rubbers, etc.

One of the outstanding properties of silicone is water repellency, and this has enabled the development of Tretol External Impregnation — the Silicone Waterproofer — a lasting water repellent for roughcast, brickwork, cement renderings, concrete, etc.

It is claimed that surfaces of masonry correctly treated with this material are extremely difficult to wet with water, since the latter will simply form droplets on the surface and run off. The highly penetrative properties of silicones enable Tretol External Impregnation to penetrate deeply into building surfaces, lining the pores with a water repellent film without altering the appearance or " breathing " characteristics of the masonry.

This water repellent, which is manufactured by Tretol, Ltd., London, can be applied by brush or spray in one or two coats, according to porosity of the surface, and the material needs no special skill in use. It is completely invisible on application.

Oily-Water Separator for London Dock

Coastguard Separators, Ltd., Newcastle, makers of the completely automatic "Autosep " oily-water separators, have received an order from the London Graving Dock, Ltd., for a 125-ton separator to be installed as a shore station. Coastguard Separators have previously supplied the London Dock with 50-ton and 100-ton separators, which were installed in their two harbour barges on the Thames. "Autosep " separators are now in use as shore stations on the Tyne, Wear, Thames and the Bristol Channel.